Charles University in Prague

Faculty of Social Sciences

Institute of Economic Studies

MASTER THESIS

ASSESMENT OF ETHIOPIAN MONETARY POLICY: THE PROSPECT OF INFLATION TARGETING USING MONETARY VAR

Author: Mustofa seid Jehar

Supervisor: PhDr. Jaromír Baxa

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Declaration of Authorship

The author hereby declares that he compiled this thesis independently, using only the listed resources and literature.

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Prague, July 31, 2011 Signature _____

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Abstract

This paper tries to assess the Ethiopian monetary policy, in order to investigate the prospect of inflation targeting. The paper starts by reviewing the literature on the evolution of Ethiopian monetary policy and Macroeconomy. This is followed, by the requirements of adopting inflation targeting and the practical experience of inflation targeting countries; finally the paper focuses on the requirement to have a stable and persistent relationship between the policy instrument and price level. Vector auto regression model with some monetary policy instrument and macroeconomic variables was used. To explore different transmission mechanism i have analyzed the Granger causality, impulse response, and Variance decomposition. Result showed that, there is a weak relationship among prices, interest rate and exchange rate channel. The paper, therefore, recommended it is not the right time to adopt the full-fledged inflation targeting. Rather, better try to adopt inflation targeting as an implicit policy.

Key words: inflation targeting, Vector auto regression, impulse response, variance decomposition, and granger causality.

Author's e-mail mustofa.seid@yahoo.com

Supervisor's e-mail jaromir .baxa@gmail.com

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Acronyms

GDP - gross domestic product

EXC - exchange rate

PPI- purchasing power of income

CPI - consumer price index

T-Bill - treasury bill rate

M2 - Broad money

IT - inflation targeting

VAR - vector auto regression

VECM - vector error correction model

NNEER - net nominal effective exchange rate

HCPI- headline consumer price index

Shock1- shock in GDP

Shock2- shock in CPI

Shock3 – shock in money supply

Shock4 – shock in T-bill

Shock5 – shock in exchange rate

Master Thesis Proposal

Institute of Economic Studies
Faculty of Social Sciences
Charles University in Prague

Author:	**Mustofa seid jehar**	Supervisor:	PhDr Jaromir baxa
E-mail:	Mustofa.seid@yahoo.com	E-mail:	jaromir.baxa @ centrum . cz
Phone:	774106634	Phone:	222 112 309
Specialization:	Economics and finance	Defense Planned:	June 2012

Proposed Topic:

Assessment of Ethiopian monetary policy: the prospect of inflation targeting using monetary VAR

Topic Characteristics:

Although there is a general agreement on the neutrality of monetary policy in the long run, there is a disagreement on its impact in the short run. Accordingly while the neo classical economists believe that systematic monetary policy will not have an impact on the real variables, to the contrary the neo Keynesians economists believe that systematic policy will have an impact to the real variables. When we see empirical results it is not clear cut. But the one thing they both agree is that monetary policy can be used to keep price stable (not to be a problem by itself). However the disagreement of economists will not end here, beside to the above disagreements economists do not agree which specific monetary policy we have to use even to make the monetary policy of being a problem by itself.

Taking the above arguments in to account this paper will try to assess the current monetary policy in Ethiopia and evaluate its performance towards achieving stability of price and exchange rate. At last but not a least this paper will try to see if there is a need for another monetary policy to achieve the above objectives.

Research question

1. What is the reason for the current objective of the monetary policy in Ethiopia?
2. What is the current performance of Ethiopian monetary policy in terms of achieving its stated objective?
3. Is there any room or need for another monetary policy? If any is it applicable with the current economic scenario?

Hypotheses:

1. The current monetary policy is not fostering sound financial system and economic growth
2. The current monetary policy is incapable of keeping stable the price level and the exchange rate.
3. Some Africa countries like Ghana and south Africa are able to apply inflation targeting therefore there is no reason why not in Ethiopia.

Methodology:

The Following models will be used in the analysis

1. Interest rate transmission mechanism
2. Exchange rate channel
3. monetary channel

Appropriate econometric methodology will be used to estimate the models and data from data set national bank of Ethiopia and IFS will be used.

Outline:

1. Part : 1 introduction
2. Part : 2 review of monetary policy in ethiopia
3. Part : 3 review of emperical and theoretical litrature
4. Part : 4 methedology and data
5. Part : 5 estimation of the model
6. Part : 6 conclussion and recommendation

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Author

Supervisor

CHAPTER ONE: INTRODUCTION

1.1 Introduction

There are some disagreement regarding the effectiveness of monetary policy in both long run and short run. However, before discussing different empirical findings both who support and argue the effectiveness of monetary policy, it will be helpful to give the theoretical explanation of monetary policy. Monetary policy[1] is a practice in which the monetary authority or the national bank of a country manages the supply of money, the cost of money or rate of interest, and availability of money to achieve a set of objectives (price stability, exchange rate stability, full employment and high rate of growth).

In 1990's, there was a wide disagreement between economists over monetary policy effectiveness over the long run. Although it is difficult to suggest the causality, McCandless and Weber (1995) observed that there is a high correlation between money growth and inflation. In their study, they also found that there is no correlation between inflation, money growth and economic growth. This finding was supported by Kormendi and Meguire (1984) that found no long run relationship between money and output growth using the sample of 50 countries. However, Baro (1995) found that a negative correlation between inflation and output growth.

Since the early 2000, economists were coming in to an agreement, regarding the long run impact of monetary policy. That is they started to conclude that monetary policy will not have long term impact on real economic variables. However, they still do not agree over its impact to the real economic variables. Some of them assume monetary policy can stimulate an economy; while some of them believe in its neutrality. Nevertheless, there is a general agreement; monetary policy can be used in controlling inflation pressure. That is we can control monetary policy of being a problem by itself.

[1] According to , MILTON FRIEDMAN (1968) in the paper called " the role of monetary policy "

However, the disagreement among economist with regard to monetary policy do not stop here; There is also another disagreement among economists over which monetary policy to use and which of them are effective taking in to account the condition of countries. The most Common monetary policy used by different countries is monetary targeting, exchange targeting, price level targeting and inflation targeting. In line with these monetary policies, they use different instruments such as the discount rate, open market operation, and mandatory reserve rate requirement. However, the ultimate objective of the monetary policy differs from country to a country where in some countries they put stable economic growth and low unemployment as their ultimate objective others put low inflation as their ultimate objective. The setting of the objective is directly related with the perception of monetary policy impact.

However, starting from 1990's on and the start of new millennia inflation targeting monetary policy has been increasingly viewed as a superior monetary policy framework and was highly praised by economist and policymakers at the same time. Because of its massive potentials as an effective instrument of managing inflation, countries that have adopted it never turn back; with the exception of Slovakia, Finland and Spain which joined the euro currency area. Inflation targeting monetary policy regime tries to make public a projected, or targeted inflation rate and then tries to bring actual inflation towards the target through the use of interest rate changes and other monetary tools.

According to Svensson (1999) inflation targeting (IT) framework stipulates exceptionally clear goals for monetary policy, establishes measures of transparency and accountability, and defines responsibilities. It is, however, characterized as constrained discretion' because it requires the central bank not only set out clear targets, but also to use appropriate instruments to hit the target, Fischer (2000). Loayza and Soto (2002) examined that although the term inflation targeting is frequently used by policymakers' bankers, politicians and scholars quite a lot features of this monetary regime and its effects on economic performance remain subtle. After facing moderate, but, persistent inflation rates for over twenty years, developed countries have controlled and maintained inflation at historically low levels in recent years. Statistical

Evidences have shown that Inflation targeting frameworks has often been adopted in economies even if they do not have stable inflation historically ; this is typical particularly for countries of Africa and Latin America who were seen as an archetype of unceasingly high inflation. For example, Brazil and Chile had an inflation rate of 19 percent and 26 percent, respectively, prior to the adoption of inflation targeting, and they have had a success story in controlling inflation using inflation targeting.

However, until now the number of countries who adopted fully fledged inflation targeting is exceedingly few and it is mainly adopted by developed countries. Although there are some developing countries that started to apply the monetary policy, still the number of developing countries who applied is unusually small. Their inability is originated by the requirements for the successful adoption of the fully fledged inflation targeting[2]. Those requirements are: predictable relationship between consumer price index (CPI) and policy instrument variables; independence of the central bank and absence of fiscal dominance (central bank must not have the burden of financing deficit); putting in place a well defined and only one objective (inflation stability); have a high degree of transparency and accountability; have strong financial market who can absorb the allocation of public and private debt.

The paper tries to evaluate Ethiopian monetary policy and its prospect for inflation targeting. Taking in to account the ultimate objective of this paper is to check applicability of fully fledged inflation targeting in Ethiopian monetary policy. In investigating the monetary policy, I will try to see the effectiveness of the transmission mechanisms. Since, one of the requirements for a successful adoption of inflation targeting[3] is the effectiveness of the interest rate transmission mechanism; I will try to see the effectiveness of the interest rate transmission mechanism, exchange rate transmission mechanism and monetary transmission mechanism. Although,

[2] Full-fledged inflation targeting is when countries or national banks commit clearly to inflation target and underline the commitment by a transparent monetary policy framework. This in effect reduces the time inconsistency problem a Central Bank faces but, at the same time, reduces also the leeway of monetary policy to stabilize aggregate output. This policy is seen to exist in Sweden, the UK, Norway, Czech Republic, Australia, Canada, and New Zealand.

[3] Shehu Usman Rano Aliyu, a. A. (2009)

there are also other transmission mechanisms which are indispensable to look, I have only concentrated on the above transmissions.

In order to achieve the stated objective, I took consumer price index (CPI), gross domestic product (GDP), broad money (M2), Nominal effective exchange rate (NEER), and Treasury bill rate (T-BILL) as the main indicators. The above indicators were taken as the best proxy for price, output, money supply, exchange rate and interest rate respectively. In addition, some exogenous variables are also included (export, fed rate and international oil price).

To keep the stream of the paper I have organized the paper as the following way, in the first part there is the introduction and trays to show the motivation for the paper. In part two, there is Evolution of Ethiopian monetary policy and macro economy in historical perspective. In the third part of the paper, there are Empirical and theoretical literatures related with inflation targeting and monetary VAR, while the fourth part presents the research presents the data selection and methodology. At last but not the least, the fifth and the sixth part present the empirical analysis, and conclusions and recommendations respectively.

CHAPTER TWO: EVOLUTION OF ETHIOPIAN MONETARY POLICY AND MACROECONOMY

2.1 Evolution of Ethiopian monetary policy

The National Bank of Ethiopia (NBE) began operation in January 1964, after the enactment of the establishing proclamation 206 of 1963. The proclamation gave the bank juridical personality, raised the Bank's capital to 10 million the then Ethiopian dollars and granted broad administrative autonomy. Following the enactment of the proclamation the National Bank of Ethiopia was given the following specific objectives:

- To achieve balanced and sustained economic growth and development, by fostering conducive monetary, credit and financial conditions.

- Ensuring the level of money supply is generally in line with developments in the macro-economy and taking action in the exchange rate of the foreign currency for the purpose of preserving the purchasing power of the national currency.

- Through the implementation, of a prudent market driven interest rate policy, Encourage the mobilization of domestic and foreign savings and their efficient allocation for productive economic activities.

- Facilitating through appropriate policy measures to the materialization of capital and financial markets that are equipped of responding to the needs of the economy.

However, the renewed banking and monetary proclamation No. 99 of 1976 came into action following the socialist economic Principle that the country adopted and tried to shape the Bank's role accordingly. Accordingly the new proclamation allowed the Bank to participate actively in national planning, specifically financial planning, in collaboration with the other state institutions. The supervisory area of the bank was also expanded to incorporate other financial

institutions such as credit cooperatives, insurance companies and investment-oriented banks. Furthermore, the new proclamation introduced the new Ethiopian birr in place of the former Ethiopian Dollar.

To reduce the deficit and combat inflation, the government introduced a contractionary fiscal management policy in the 1980s. The government reduced the budget deficit to an average of l4 percent of gross domestic product (GDP) in the five years ending in Ethiopian fiscal year l988/89 by borrowing from local sources. For example, in Ethiopian fiscal year l987/88 domestic borrowing financed about 38 percent of the deficit. Ethiopia was also forced to take measures to cut back spending on capital and to lower inflation. Nevertheless, price ceilings, official appreciation of the birr, and a freeze on the senior government officials wages was unable to control inflation. By 1988 inflation was averaging 7.1 percent annually, but it turned sharply upward during 1990 due to the government involvement in war in different fronts; expenditures increased and were estimated at 45 percent by mid-1991. In addition to the above, money supply(M2), defined as demand deposits with banks (except that of the National Bank of Ethiopia)and currency in circulation, rose with the expansion in government budget deficits, which reached about 1.6 billion birr in Ethiopian fiscal year 1988/89. In Order To help resolve the budget deficit problem and other economic difficulties, Ethiopia relied on foreign aid.

Inflation was not a significant problem in Ethiopia until 2006, but after 2007, there was a high growth in the inflation rate and the government started restriction on credit availability to investors in order to control inflation. This policy measure helped inflation to stabilize, and in response the government lifted the credit restriction in 2008/09. However In 2010 management of macroeconomic variables was problematic because of the sharp depreciation of the national currency (birr) and rising level of inflation. The government tried to deal with inflation through different combination of monetary policy instruments, i.e. the contraction of money supply growth and availability of credit to investors and households. The government devalued the national currency by 20% in 2010 with the objective of increasing the level of

external reserves and increase earnings from export. This devaluation made to aggravate inflation through imported inflation (fuel and some other consumer products). To alleviate the side effects of the policy measure, the government intends to use monetary policy measures to keep inflation below 10% starting in 2011 and through the duration of its five-year plan. Many scholars and economists blame to the governments cheap monetary measure in order to boost the economic growth.

Based on government's growth and transformation plan for the year 2010 to 2015, the government delineated a monetary policy that set a target for the next five years of below 10% inflation. Money supply is expected to grow at a level consistent with real gross domestic product (GDP) growth targets, annual inflation targets (CPI and PPI), and at the economy's monetization rate. However, restraining inflation to a single digit from its current double digit is a colossal challenge for monetary policy. The projected high GDP growth and investments required to achieve it will have an impact on foreign exchange demand and could lead to a further depreciation of the Birr.

2.2 Evolution of Ethiopian Macroeconomy

Like other developing economies, Ethiopian economy heavily depends on agriculture; accordingly it constitutes 42 % of the gross domestic product (GDP) and generates more than 80% of the export commodity of the country. Not surprisingly more than 80 percent of the population sustains their life in the sector. Coffee is the foremost agricultural export crop, contributing for about 65% ten years ago. However, this sharply decreased to only 26% of Ethiopia's foreign exchange earnings, because of the drop in coffee prices since the mid-1990s and increases in other exports. Other traditional principal agricultural exports are hides and skins, leather, oilseeds, pulses, and the traditional "Chat," a chewed narcotic leaf. Sugar and gold production have also become significant in recent years.

When we see the economic growth of Ethiopia unlike to the end of 1990's and the beginning of the millennia and before, Ethiopia is showing enormous economic growth since 2003 to date.

Surprisingly, Ethiopia continued to register the fast growth for the last seven years. In the considered years, Gross domestic product (GDP) was growing by more than 10% with the exception of the year 2008. In 2010, the GDP growth remained strong at 11.5 %. This Growth is driven by the service sector (15%), followed by the industrial sector (12.5%) and agricultural sectors (9%). The service is leading the growth of GDP due to the involvement of private financial institutions (banks, insurance and microfinance), hotels and restaurants, real estate and public services.

Table 1 Real GDP growth

Period	Real GDP growth	Real GDP growth			contribution to GDP growth		
		Agriculture	Industry	Services	Agriculture	Industry	Services
1998	5.2	1	0.2	3.9	-	-	-
1999	5.9	3.4	0.6	1.5	2.2	1.8	9.5
2000	7.4	4.8	0.7	-0.2	10.6	4.8	3.8
2001	1.6	-1	0.8	1.9	-2.1	5.1	-0.5
2002	-2.1	-4.3	0.9	1.3	-11.6	5.5	4.4
2003	11.7	8.1	0.9	2.3	17.3	6.8	5.8
2004	12.6	6.4	1.3	5.1	13.5	9.4	12.8
2005	11.5	5.1	1.4	5.4	10.9	10.2	13.3
2006	11.8	4.3	1.3	6.3	9.4	9.5	15.3
2007	11.2	3.2	1.3	7	7.5	10	16
2008	9.9	2.5	1.3	6.1	6.4	9.9	14
2009	10.4	3.2	1.4	6	7.6	10.6	13
2010	11.5	4.69	1.53	5.26	9	12.5	15

Sources: national bank of Ethiopia 2010 -2011 annual report

In spite of the above growth in the economy, Ethiopia continues to struggle with the challenges of high inflation, budget deficit, and exceptionally low international reserves. This can be seen from the table below, starting from 2002 onwards we see that both the GDP deflator rand CPI increasing in an alarming rate. GDP deflator and CPI slowed in 2009; however, this did not last long, and CPI increased vigilantly in the following year. At this period, the government took some measures to decrease the inflation rate; including restriction in the credit availability to investors and consumers, through the regular banks and micro finance institutions.

Table 2 Alternative inflation measure/indicators of Ethiopia

period	GDP deflator	CPI		
		general inflation	food inflation	Non food
1998	0.7	4.3	9.9	-2
1999	6.9	5.4	7.6	2.5
2000	-5.8	-0.3	-1.7	1.4
2001	-3.6	-10.6	-19.1	0.3
2002	12.8	10.9	21.5	0.2
2003	3.9	7.3	11.5	2.2
2004	9.9	6.1	7.4	4.4
2005	11.6	10.6	10.6	7.1
2006	17.2	15.8	15.8	13.5
2007	30.5	25.3	25.3	12.5
2008	24.4	36.4	36.4	23.8
2009	3.5	2.8	2.8	18.2
2010	3.2	18.1	18.1	21.8

Sources: national bank of Ethiopia 2010 -2011 annual report

If the government growth and transformation plan (GTP) is successful, the growth prospects for 2011 and 2012 are likely to be as positive as in 2010. The GTP plan calls for the agriculture sector to become the principal source of economic growth. However, unlike the previous plans which solely depend on agriculture, the government intends to promote industrialization through increasing exports and import substitution. Therefore, based on GTP the economy is projected to grow at an average annual rate of 10% in 2011. Industry and services are expected to show an average annual growth of 20 and 11% respectively during the planned five-year period of the government, while the agriculture sector is expected to grow by 8.1%.

Before 1991 the source of government budget deficit was the excessive militarization of the country to fight with Somalia 1979 and internal civil war with Eritrea and Tigray. In the stated time Ethiopia was importing weapons from united soviet Russia and was unable to get financial aid from western countries because the ideology of the military junta . However after the over through of the military government the military expense of the country sharply decreased and

there was an abundant flow financial aid and loan grants to the government to finance the development activity of the country.

Therefore Ethiopia's external debt declined to a historic low in 2006/07. Ethiopia received debt relief of 21% of GDP in 2006/07 mainly because of the World Bank's 100% cancellation of the country's debt to the International Development Association. Total external debt fell sharply from 85.4% of GDP in 2002/03 to 11.7% in 2006/07 before steadily rising to reach 14.8% in 2008/09 and hitting 22.2% in 2011. This trend is expected to remain intact in 2012. Similarly, the external debt service ratio declined from 7.3% in 2002/03 to 1.2% in 2007/08. However, it has risen to 3% in 2008/09 and remained at the same rate of 3% in 2010. One aspect of Ethiopian debt worth watching is the rapid rise in debt owed to non-traditional partners such as China. Unlike to the traditional way of debt to western countries the debt of Ethiopia is with china and some other BRIC[4] countries. This is because the western means of loan requires a lot of bureaucracy, however, in the case of china and some other BRIC countries it is relatively very easy.

In a nut shell In terms of the structure of GDP, the dominance of the agricultural sector changed in 2009 as compared from 2005.[5] Thus, in 2009 the most dominant sector of the economy in terms of its share was the service sector at about 43.9% of GDP. This is followed by the agricultural sector with a 43.2% share in GDP. The industrial sector's share remained largely unchanged from last years with its share of GDP at about 13.0%. The manufacturing sector, within the industrial sector, also remained weak in 2009, at 4.9% of GDP.

[4] This is a group of emerging countries with strong economic growth (brazil , Russia ,India and china)
[5] African Economic Outlook 2012 - © OECD 2012

CHAPTER THREE: LITERATURE REVIEW

3.1 Inflation targeting in emerging and developing countries

As a conventional monetary policy regime, Inflation targeting was first introduced in New Zealand in 1990. Since that time, it has been implemented by several countries around the world. In the beginning of 1990, the countries that started adopting inflation targeting to their monetary policy were developed countries. The performance of inflation targeting countries has been remarkably beneficial. It seems that, inflation targeting countries have significantly reduced their inflation rate and inflation expectation from what could happen if they did not introduce inflation targeting. (Mishkin 1999, 595)

By observing the above results, after the end of 1990 and the beginning the new millennia emerging and developing countries started to introduce the inflation targeting to their monetary policy. As a result, result countries like Chile, Colombia, South-Africa, Thailand, Mexico, Peru, Philippines, Guatemala, Romania, Serbia and Ghana introduced inflation targeting starting from 1999 to 2007. However, despite the above development, formal inflation targeting is not yet common in African countries, with only Ghana and South Africa having officially adopted the framework at the current time. (Svenson 2010)

Emerging and developing countries adopting the IT regime saw greater falls in average inflation, growth volatility and inflation volatility than those who did not. Here, caution were made Taking in to account there may be the possibility of intelligible mean reversion effects for the case of inflation and its variability, since they were initially higher in countries belonging to the IT group. Therefore, even after controlling for mean reversion, inflation fell more vigorously in the IT group. (Carols 2005)

Besides the above finding the same paper, by the same author, proof that IT will not have a negative impact on the economic performance of the targeting country. Unfortunately to previous researches and fortunately for IT, the increase in GDP growth in the IT group was, in

fact, even modestly higher than the increase in growth experienced by non targeters. (Carols 2005)

Given the growing number of developing and emerging countries adopting inflation targeting, the key challenge for those countries is endogen-sing the frame work to their domestic condition. The second vital challenge, applicable for all countries, is how to take better explanation of vulnerabilities in the inflation target frame work and financial structures. (Scott, roger 2009)

3.2 Implementing inflation targeting in emerging and developing countries

Emerging and developing countries, introducing inflation targeting, encounter a number of hurdles that differ in character or design from those faced by developed countries. Calvo and Mishkin (2003) jot down five vital hurdles for developing countries. These include weak public sector financial management; weak financial sector institutions and market; low monetary policy credibility; extensive dollarization of financial liabilities; and vulnerability to sharp changes international investment sentiment and in capital flows.

However, this does not mean the above challenges are the only challenges those countries can face in the way of their implementing inflation targeting. (Scott roger 2009) These include uncertainty about the structure of their economies, the monetary transmission mechanism and the cyclical condition of the economy than is typically developed countries inflation target. In the next paragraph, I will discuss in detail the challenges that will be faced by developing countries in adopting inflation targeting.

Bringing public sector finance in to order: fiscal dominance, the treat of it, may undermine inflation targeting. The success of inflation targeting or any other monetary regime requires the absence of fiscal dominance. Therefore, implementation of inflation targeting must be accompanied by strong fiscal regime. (Arminio and Goldfajn 2003)

Objectively, fiscal policy, which is essentially incoherent with the inflation target, can prompt an exchange rate calamity just as it may escort to the collapse of an exchange rate peg. However, it is also possible that adoption of inflation targeting may help as a channel for public sector financial reform accurately by stressing the inconsistency of fiscal indiscipline with the objective of low and stable inflation.

Adoption of inflation targeting, as economic reform package, complicates monetary policy conduct. A reform like this affects long run equilibrium values and dynamics of macroeconomic variables because this reform is structural change by nature. This structural change in turn will make it exceedingly difficult to forecast with precision to the economic development. However, such problems do not necessarily prevent inflation targeting Batini and Laxton (2005).

When formulating and implementing inflation targeting, it is required to take in to account, weak financial sector institutions and markets. According to Laurens and others (2005), the weakness of financial institutions can affect the relative efficiency and effectives of monetary transmission through different channels, needs to be taken in to account in policy formulation.

In case of emerging and developing countries, the role of exchange rate is crucial in inflation targeting frame work. According (Taylor 2001) inflation targeting central bank should not react to exchange rate movement, he assumes it will be reasonable only, if the outlook is it will affect inflation and output. However, the global financial crisis has revealed the significance of financial vulnerability and high dollarization for emerging and developing countries inflation targeters. Mishkin (2003) pointed out that far-reaching dollarization of the economy can significantly change the transmission of monetary policy. A number of highly Euroized Central and Eastern Europe countries appear to be having exactly this problem.

3.2.1 Financial Stability and Inflation Targeting

Central banks are forced to reassess the relationship between monetary policy and financial stability after the global financial crises. Here, the solution to the problem is related with the diagnosis of the cause of the problem. The cause of the crises is explained differently by different researchers. The first argument is by Taylor (2009) monetary policy in USA and euro area was too loose for too long. The second argument is by Borio, and Lowe (2002) the crises are due to monetary policy in the leading economies being too narrowly focused on medium term inflation and paying little attention to financial development and their implication of long term inflation. The final argument is that, financial sector deregulation and regulatory arbitrage led to a loosening of monetary conditions in the United States and elsewhere; that was not effectively taken into account in setting monetary policy.

There is an analogous in the reaction of monetary policy, between the development in financial stability, and exchange rate development. From this perspective, one could argue that there is no much benefit for the monetary policy maker to react directly to the development in the financial stability. If we assume the financial sector development is captured in macroeconomic analysis and forecast of the national bank, one can argue that, some benefit can be gained from an indirect response to the extent that financial sector developments affect the outlook for excess demand and inflation. However, the fact to the matter is, most Inflation Targeting central banks' analytical frameworks are incomplete with regard to macro-financial interactions Bernanke and Gertler (2001) and Bean (2004).

It was reviled that inflation targeting countries to give greater attention to Macroeconomy and financial stability after the global crises. Traditionally all inflation targeting countries, macroeconomic models used in monetary policy analysis and forecasting do not have complete representation of financial sector. In addition, there is no representation of interaction with in the financial sector. Therefore, solving such problems is not easy; however, incorporating financial development is crucial in monetary policy analysis and forecasting.

There must be alternatives for central banks to react directly to financial stability indicators Borio and Lowe (2002) or Cecchetti and others (2000). This means that, some financial stability indicators would be incorporated directly to the central bank reaction function. If the financial sector, stability is adequately represented in the model of the central bank model, reacting to financial problem directly will have a problem. However, if, it is not adequately represented, reacting directly to financial problem will be helpful even if it is not for all financial shocks. However, due diligence must be made in determining which financial model to represent and how to include them in the central bank reaction function Walsh (2009).

The other complication is extending the inflation targeting horizon, so as to be able to take in to account long term inflation risk due to asset price cycles. This method is less mechanical as compared to reacting directly to asset prices. However to rip this advantage some challenges must be addressed. Specifically Lengthening of the forecast horizon and appropriate timing of actions need to be solved. In addition to the stated issues, policy communication also needs to be strengthened Bean (2004) and Gruen and others (2003).

At last but not least emerging and developing countries could face a problem, in introducing an element of the price path targeting as an alternative to inflation targeting. If successfully done, this may extend the monetary policy horizon in a way that ensures a long term commitment to price stability. In line with the above, Walsh (2009), stated that price path targeting would have the far-reaching benefit in influencing expectation, which will help decrease adverse effects of zero lower bound on nominal interest rates.

While the above complications are more or less related with the implementation of inflation targeting in emerging and developing countries, there are also other issues required to be addressed before adopting inflation targeting as a monetary policy. The other aspect, which needs due consideration at the time of implementing inflation targeting, are discussed in the next section.

3.2.2 Conditions that have to be in place at the time of the adoption of inflation targeting:

Masson, Savastano, and Sharma (1997) stated that before a country started adopting inflation targeting it needs to satisfy two most essential conditions. First, a country should have a central bank with a degree of independence and capable of conducting its monetary policy. However, this may not mean the central bank should have full independence. Nonetheless, a Country will have to exhibit no significant symptoms of fiscal dominance in order to comply with this requirement. The second requirement according to these researchers is the country should not have any firm objective to target the path or level of any other nominal variable by the authorities.

In the same manner career, Schaechter, stone and Zelman (2002) stated three prerequisites before adopting inflation targeting as the monetary policy. First, the central bank is required to have a defacto mandate to pursue its objective and the public must be informed about the inflation target. Second, it must be ensured not be subordinated, inflation target, by another objective. At last but not the least, they must ensure the financial system is developed, and stable enough to implement the frame work.

The finding of Batini and Laxton (2006) also supports what was stated by the above authors with its own category and explanation. Therefore, they have categorized the requirements in to four: one, the central must have full legal independence and be free from fiscal and political pressure that creates conflicts with inflation objective. The next requirement is the ability of central banks to have inflation forecasting and modeling ability and the required data to implement inflation targeting. The other relevant requirement is that, prices must not be regulated; the sensitiveness of the economy to commodity price, dollarization and exchange rate must be minimal. The last requirement is the banking system should be sound, and capital market must be well developed.

3.2.3 Instrumental issues in inflation targeting

Inflation targeting central banks commit themselves usually over a one-year horizon to a target measure of inflation. However, the target level and the horizon of the target differ from country to the country; especially in the case of which target to target there is no consensus. Some countries use core inflation (which ignores consumption expenditure on energy and food items) while others focus on the total consumer index (CPI). Gomez, González, Melo and Torres (2006) suggested in developing countries with inflation targeting regimes Using total CPI may be more appropriate for two reasons. First, the budget share of household food expenditures in developing countries is exceedingly higher than in developed countries. Second, there is high volatility in the food expenditure as compared to the developed countries in the developing countries.

Currently countries like Brazil, Colombia, , Israel, Mexico, New Zealand, Spain, Sweden, Poland and Switzerland use total CPI; and others such Australia, Canada, Korea Republic, Thailand and Iceland use core inflation (Aboal et al. 2004, and Schmidt-Hebbel, 2000; Debelle, 1997; Mishlin). The main assertion in favor of using total consumer price index (CPI) is that the general public and economic agents create expectations and make decisions based on total consumer price index (CPI). Furthermore, according to (Minilla et al., 2004) economic agents and the general public are affected by the whole basket of consumption, not just by the core items. On the other hand, supporters of using core inflation argue total inflation price index (CPI) is affected by exogenous factors, which cannot be controlled by the monetary authorities ; and it is essential to have less sensitive measure to short-term price changes and more reflective of the long-term trends.

Most inflation targeting developing and emerging countries set their target based on total consumption price index (CPI). This is reasonable, because their share of food expenditure in a household is high and most contracts are indexed to total CPI. In a nut shell, in developing countries total CPI (general CPI) is more representative of in measuring the change in the purchasing power of Income (PPI) than any measure of core inflation.

The other instrument aspect that is required to be determined is the optimal inflation rate. In most of the developing and emerging countries, there is no agreement about the optimal inflation rate for their economy. The disagreement on a quantitative value makes the choice of targeted variable's nature random. Nonetheless, there seems to be a general supposition that developing and emerging countries should probably plan at attaining a medium term rate of inflation. Therefore, the medium term target has to be somewhat higher than what the developed countries target (between 4 and 8 percent per year). In addition, it must be tolerated for the policy maker to set his inflation target within the band to help Accommodate with larger supply shocks (Masson et al.. 1997).

3.3 Inflation targeting in practice

Currently Central banks from developed, emerging and developing countries adopted inflation targeting. These countries constitute from all the continents.

Target level

According to the new Keynesian paradigm and Friedman rule, inflation rate should be zero or negative respectively. However, in reality we observe, all inflation targeting countries having positive targets. This is due to different reasons one, statistical reason i.e. actual inflation tend to be overstated by 0.5 percentage points, the second reason is due to the argument that the cost of deflation is greater than the cost of inflation. At last but not the least, if there is a down ward nominal wage resistance, a positive inflation target is desirable to avoid the risk of deflation.

The table below shows that, the numerical inflation targets in developed countries all have inflation targets between 1% and 3%. Korea Republic is at the top of this narrow range, with a target of 3% plus or minus one percentage point. Some emerging countries also have inflation targets in this range; 2% in the Czech Republic, 2% in Peru; and 2.5% in Poland. Additional three

countries Mexico, Hungary and Chile have a target of 3% and Colombia had a target range of 2%–4%. Only two countries have a target above 5%, namely Indonesia and Ghana with a target of 6 and 10 percent point respectively.

Target horizon

The second noteworthy aspect to see, in inflation targeting countries, is the target horizon. In almost all countries with inflation targets of 3% or less, the target horizon tends to be medium term. This is because medium term targets have the advantage of observing inflation expectation closely and allow the inflation rate to diverge from the target in the period of volatility in the economy. The other possible reason is the length of the transmission mechanism. That is, the interest rate transmission mechanism may not be effective in the short run.

The other target horizon is annually, this is often set where a disinflationary strategy is employed. In emerging markets, there is often a quicker transmission mechanism, so a shorter horizon policy instrument is advisable. Beside to the above reason this horizon can be seen as advantageous for the purpose of accountability. The prominent country with this regard is Brazil.

Target measure

All inflation targeting countries use the headline consumer price index (HCPI) as their operational target. This is due to three reasons: First, CPI is available on monthly level, whereas GDP deflator is available only quarterly. Second, the public is familiar with headline consumer price index (HCPI). For instance, Korea used the core measure of inflation until 2006 but due to the above reason they changed it in to headline CPI. The third reason is, the core inflation measure exclude food items because they are volatile; But, doing so means excluding about 40% of CPI baskets, and excluding it would lack credibility especially in the case of developing countries.

However some countries try to substantiate their headline CPI by core inflation as an indicator of underlying inflationary pressures in the economy. Therefore Australia, Canada, Czech Republic, Ghana, Hungary, Norway, Poland, Sweden and Turkey all publish forecasts of core inflation in addition to headline inflation.

Point or range targets a point target will help to have a clear objective to pursue. However, it is extremely difficult to achieve the target month in month out. This will have the tendency to erode the confidence of the public. Therefore, a point target will be preferable when the volatility of inflation outruns is wider than the width of a narrow band. The other alternative is the target range, by this target any one can see whether the target has been hit or missed and allows output to stabilize; But, Ranges can also pass on the sense that the central bank has wooly control over the inflation objective.

As we can see, from the table, 17 of inflation targeting countries express their target as a point with a tolerance band. Five central banks (Hungary, Iceland, Norway, Sweden and the United Kingdom) have restrained point targets while the other five countries have a target range.

Table 3 inflation targeting countries and their detail information

Country	Numerical target	Target measure [6]	Date of adoption	Inflation rate at the time of adoption [7] (percent)	2010 end of year inflation [8](percent)	Target horizon [9]	Previous anchor
Albania	3% (±1)	HCPI[10]	2009	3.7	3.40	NA	NA
Armenia	4.5 % (±1½)	HCPI	2006	9.35	9.35	Medium term	NA
Australia	2-3%	HCPI	1993	2.0	4.03	Medium term	None
Brazil	4½ % (±2%)	HCPI	1999	3.3	5.91	Yearly target	Exchange rate
Canada	1-3% (2% central value)	HCPI	1991	6.9	2.23	Six to eight quarters	none

[6] Gill Hammond ,2012 , " state of the art of inflation targeting -2012" ,centre for central banking studies , page 9
[7] Roger, Scott, March 2010,"inflation targeting turns 20". The inflation rate at the time of adoption for Slovakia is not there, because Slovakia abandoned inflation targeting after joining the euro currency. Beside to that I did not incorporate Spain and Finland since they abandoned it for the same reason.
[8] Sarwat , jahan , " inflation targeting : holding the line "
[9] Gill Hammond ,2012 , " state of the art of inflation targeting -2012" ,centre for central banking studies , page 9
[10] Where **HCPI** is head line consumer price index

Chile	2-4%	HCPI	1990	3.2	2.97	Two years	Exchange rate
Columbia	2-4%	HCPI	1999	9.3	3.17	Medium term	Exchange rate
Czech republic	3% (±1%)	HCPI	1998	6.8	2.00	12-18 months	Exchange rate and money supply
Ghana	0-10%	HCPI	2007	10.5	8.58	18-24 months	Money supply
Hungary	3% (±1%)	HCPI	2001	10.8	4.20	Medium term	Exchange rate
Iceland	2½ % (±1½%)	HCPI	2001	4.1	2.37	On average	Exchange rate
Indonesia	6% (±1%)	HCPI	2005	7.4	6.96	Medium term	Money supply
Israel	1-3%	HCPI	1992	8.1	2.62	Within Two years	Exchange rate
Mexico	3%	HCPI	1999	9.0	4.40	Medium term	Money supply
New Zealand	1-3%	HCPI	1990	3.3	4.03	Medium term	None
Norway	2½%	HCPI	2001	3.6	2.76	Medium term	Exchange rate
Peru	2% (±1%)	HCPI	2002	-0.1	2.08	At all times	Money supply
Philippines	4-5%	HCPI	2002	4.5	3.00	Medium term	Exchange rate and money supply
Poland	2½ %(±1%)	HCPI	1998	10.6	3.10	Medium term	Exchange rate
Romania	4% (± 1%)	HCPI	2005	9.3	8.00	Medium term	Money supply
Slovakia	0-2%	HCPI	2005	-	-	-	Exchange rate
South Africa	3-6%	HCPI	2000	2.6	3.50	On continuous basis	Money supply
South Korea	3% (±1%)	HCPI	1998	2.9	3.51	Three years	Money supply
Sweden	2% (± 1%)	HCPI	1993	1.8	2.10	Two years	Exchange rate
Switzerland	0-2%	HCPI	2000	-	-	-	Money supply
Thailand	0-3½%	HCPI	2000	0.8	3.05	Eight quarters	Money supply
Turkey	4% (±2%)	HCPI	2006	7.7	6.40	Three years	Exchange rate
United kingdom	2%	HCPI	1992	4.0	3.39	At all times	Exchange rate

Sources: petursson, Thorarinn G. (2004), formulation of inflation targeting around the world, monetary bulletin 2004/1, 57-84 and central bank websites.

3.4 Experience with inflation targeting in Africa: South Africa and Ghana

Currently there are two sub-Sahara Africa countries which adopted inflation targeting formally. These contraries are South Africa and Ghana which adopted inflation targeting in 2000 and 2007 respectively. Therefore, in order to shade some light to my analysis, I will present some literature regarding their achievement and challenges in detail.

South Africa

In South Africa, when inflation targeting was introduced in 2000, it was decided that a modified version of the consumer price index (CPI) labeled the CPIX, would be used to calculate inflation rates. The CPIX was calculated in a way it excludes the financing component of housing costs. The rationale for excluding mortgage interest from the CPI is that most South Africa mortgages are flexible rate mortgages. It means that if these dynamics affects the measurement of price inflation, then the central bank could respond to increase in market interest rate by increasing its policy rate. That is the central bank will exacerbate the increase in interest rate. In addition to that, it was also decided the target range to be 3% to 6%. James Heintz and Le´once Ndikumana (2011) The trend of inflation shows that the Reserve Bank of South Africa was able to meet its target about half the time since announcing the policy of inflation targeting. Particularly the period from 2003 fourth quarter to 2007 first quarter was the most successful period in terms of achieving its target. This period was also accompanied by relatively strong economic performance and high average rate of GDP growth, compared with earlier years pre inflation targeting and post apartheid era. James Heintz and Le´once Ndikumana (2011) the other aspect of inflation targeting worth answering is, has the inflation-targeting regime in South Africa influenced expectations? Aron and Muelbauer (2007), in their review of monetary policy in South Africa, mentioned facts that inflation expectations, mainly in wage setting, come out to be historically based, and are frequently not forward-looking. These findings would indicate that expectations among South African will be difficult to shift simply by announcing a target range of inflation. At last but, not the least, the same authors found that after the introduction of inflation targeting there was a significant improvement in the transparency of

monetary policy. However, achieving better transparency does not mean there will be an increase in the perception of credibility of central bank policy through influencing expectation.

Ghana

Ghana adopted inflation targeting officially in May 2007. In the initial period, the target was jointly determined by the bank of Ghana and the government. In effect, they determined the target rate to be from 7% to 9 %. Amoah and Mumuni (2008) in measurement of the price they used to target inflation by excluding petroleum price and utilities. The argument here is the same like that of South Africa energy prices can be quite volatile and clearly represents a non-monetary source of inflationary pressures. However, excluding energy component from CPI does not entirely eliminate the influence of changes in energy price on inflation. Pollin et al (2008) The trend of inflation in Ghana is still increasing from 10% in 2007 to 20% 2009, however, this mainly because of imported inflation. It means that the central bank is missing its target.

Unlike to the other inflation targeting countries, when the inflation target is missed, the bank of Ghana does not produce an open letter of a formal report explaining the deviation. The bank simply communicate its policy through a press release after the monetary policy committee meetings, publishes routine reports and maintaining information in its website. Therefore, it is unknown how effective these means of communication are in influencing expectations and enhancing policy credibility. Amoah and Mumuni (2008) However, here what we have to take in to account is it is too early to judge the inflation targeting in Ghana taking in to account it is only five years since they adopted inflation targeting formally.

3.5 Monetary vector auto regression (VAR) in developing countries

In this section, we will see some literatures concerning the effectiveness of monetary transmission mechanisms in developing countries. Notably, asset price channel, balance sheet channel, bank lending channel, exchange rate channel, expectation channel and interest rate

channel. Since now a day's VAR analysis is preferable to analyze the effectiveness of these channels we will see literatures which have used this methodology.

Era Dabla et al (2006) they found that, output will be considerably affected due to shocks to domestic monetary aggregates, but this appear to have no significant impact on prices. However, they found that inflation in Armenia does respond to changes in broad money (M2), once foreign currency deposits are incorporated. Even though, there is some evidence for a transmission of shocks to the repo rate to CPI inflation, the interest rate channel remains weak. As in many emerging and developing economies with a high level of dollarization, the exchange rate channel appears to have a stronger impact on prices.

Therefore, the overall result shows that, the central bank's means to influence economic activity and inflation are extremely limited. For a successful transition, to a full-fledged inflation targeting monetary policy framework improving the performance of these channels will be leading. At the same time, Leiderman, Maino, and Parrado (2006) found that the way the monetary policy responds to an economic change is dependent on the regime.

In the developing countries, unlike the developed countries, the transmission of monetary policy is relatively little known about the way money shocks are transmitted to the real sector. Carlyn Ramlogan (2004) in his paper to conduct an empirical analysis of monetary transmission mechanism in Jamaica, Trinidad, Barbados and Guyana and found from his VAR analysis in all four countries that the credit and exchange rate channels are more influential than the monetary channel in transmitting impulses from the financial sector to the real sector.

Buigut (2009) examined monetary transmission mechanism in Kenya, Tanzania and Uganda. He used VAR methodology by incorporating three variables (real output, inflation and interest rate) and ordered output first and consequently inflation and interest rate. In his result, he found that the monetary transmission mechanism being extremely weak in all three countries.

In a similar manner, Lungut (2008) examined monetary transmission mechanism in Botswana, Malawi, Namibia, and Zambia. He used VAR methodology by taking in to account seven variables (industrial production (IPIX), prices, monetary base, M2, the policy rate, supply of loans and lending and deposit rate). In opposite to Buigut ordering, he ordered the policy rate first. This is due to, the assumption that monetary policy does not react to any other variables in the system. Although he found mixed result, the general pattern was the bank lending and deposit respond to the shock in expected direction. However, the shock has little impact on prices, output and total bank lending.

Along the same vein, Abradu-Otoo et al (2003) examined monetary transmission mechanism of Ghana. He used the vector error correction model (VECM) and incorporated seven variables (growth rate, inflation rate, change in the exchange rate, and credit to private investors, broad money, T-bill rate and oil price). However, in their result, they neither come with statistically significant effects of monetary policy shock nor consistent with economic theories. In both computed impulse, (using the generalized impulse) response function and point estimates.

Using more sophisticated identification strategies, Cheng (2006) examined monetary transmission in Kenya. He used VAR methodology with five variables (real output, price level, money stock, policy rate, and nominal exchange rate). He essentially used two ordering system, the first like what i have put the variables above based on the theory of Peersman and Smets (2001); and the second based on Sims and Zha (1998) in which the real GDP did not respond to any other variables in the system; price level respond to GDP; the money supply responds to all variables except exchange rate; the policy rate responds to exchange rate and stock of money. At last, but not the least he assumes that exchange rate responds to all variables. Based on both ordering, he found that the interest transmission has considerable impact on the price level and exchange rate. However, we do not see similar impact with the real variables. From these results, interestingly he concluded that the price level is affected by monetary policy through aggregate supply (in the form of exchange rate).

In 2009, Ngalawa, examined a VAR model of Malawi using the same variables as what Cheng did. However, beside to that he used bank loans and reserve money. In this system GDP do not respond to any of the variables in the system, the price level respond only to GDP, exchange rate responds to GDP and price level, the broad money responds to GDP, price and bank rate; the bank rate responds to exchange rate; the reserve money responds to all variables except GDP and price; and the bank loan responds to all variables in the system. Therefore, based on his estimation he found out that, the bank rate affects bank lending, GDP, price level in line with the theoretical expectation. However, neither of them found to be significant.

Another pertinent literature is Malick (2009) examined the monetary transmission in India. He used VAR methodology and applied the recursive ordering in his five variables (GDP, price, interest rate, long term interest and exchange rate) based on the theory of Bernanke and Blinder (1992). These restrictions need monetary policy contraction to be accompanied by the increase in both short and long term interest, decrease in price; however it left out GDP to be determined by the figure. Therefore, based on his result he concluded that shocks in the demand are of little importance.

Almost all of the above literature support a prior research conducted in this topic. That is in countries where the money market is relatively under developed the money market will not be the principal conduit of monetary policy shocks. In all these countries, investors face a limited portfolio choice and remain highly dependent on the banking system for external funding.

CHAPTER FOUR: DATA SELECTION AND METHODOLOGY

4.1 Data and Choice of Variables

I examine the impact of three policy instruments, interest rate, exchange rate and money supply. Unlike in developed countries, short term interest rate is not the main instruments of monetary policy. In spite of that I have used t-bill rate as a signal of the monetary policy motive. The second policy related variable is the nominal exchange rate. I tried to concentrate on the nominal effective exchange rate (NEER), to evaluate the impact of exchange rate changes on output and prices. To distinguish the exchange rate channel from other channels I did not use real effective exchange rate (REER). The last but not the least, policy related variable is narrow money or M1. In general, broad money M2 is also highly correlated with output and prices than M1. Therefore, I have used M2 as a good proxy for the monetary policy stance.

In addition to the previous three policy instrument variables, I have used other variables as well. That is output and the general price level. These variables are measured by real GDP and consumer price index (CPI)[11] respectively. Since it is extremely beneficial to have stationary in characterizing the relationship between output, price and policy related variables I made my data stationery. To control for over all international economic scenario I have included export (export), fed rate (fed) and international oil price (oilp).

Regarding the transformation of the data all variables except T-bill rate are in log. This is because it will be easy for the interpretation of result and to work with. To make the data

[11] The new CPI base of Ethiopia includes two indexes, the non-food index and the food index. The Food Index has 13 sub-groups these are: Cereals; Pulses; Bread and Other Prepared Food; Meat; Milk, Cheese and Eggs; Vegetables and Fruits; Oil and Fats Spices; Potatoes, Other Tubers and Stems; Coffee Beans (whole) and Tea Leaves; Other Food Items; Milling Charges; and Food taken Away from Home. On the other hand, the non food index constitutes ten major groups each, namely: Beverages; Cigarettes and Tobacco; Clothing and Footwear; House Rent, Construction Materials, Water, and Fuel and Power; Furniture, Furnishing, Household Equipment and Operation; Medical Care and Health; Transport and Communication; Recreation, Entertainment and Education; Personal Care and Effects; and Miscellaneous Goods and Services. These data are collected from 119 market places and with different weight based on the spending of the people.

stable /stationery I have differenced all the data once with the exception of exchange rate (EXC) which is differenced twice.

4.2. Methodology

This section of the paper is devoted to the introduction and detailed explanation of the methodology I have used in the paper. In order to achieve my objective I have used the vector auto regression (VAR) method. The VAR mode assumes the Ethiopian economy can be described using the following equation:

$$g(l)y_t = c(l)x_t + \varepsilon_t \quad \ldots\ldots (1)$$

Where g(l) is an n x n matrix polynomial in the lag operator; c(l) is a n x k matrix polynomial in the lag operator; Y_t is a n x 1 vector of endogenous Ethiopian variables ; and X_t is a K x 1 vector of exogenous international variables which are not affected by Ethiopia . This is because Ethiopia is a small open economy. At last ε_t is a n x 1 vector of structural disturbance, with variance of Ω. Where, Ω is a diagonal matrix.

$$y_t = a(l)y_t + b(l)x_t + \mu_t \quad \ldots\ldots (2)$$

Where a(l) and b(l) are matrices polynomial ; μt is a vector of reduced form of the disturbance terms , with variance of ∑ .

If we assume a contemporaneous coefficient matrix in the structural form F and h(l) a coefficient matrix in g(l) without contemporaneous coefficient . That is

$$g(1) = F + h(l) \quad \ldots\ldots (3)$$

The above structural and reduced form can be related like the following equation:

$$a(l) = -F^{-1}h(l) \text{ and } b(l) = F^{-1}c(l) \quad \ldots\ldots (4)$$

In the same manner the error terms are related in the following way:

$$\mu_t = F^{-1}\varepsilon_t \text{ or } \varepsilon_t = F\mu_t \text{ , which implies } \sum = F^{-1}\Omega\, F^{-1} \quad \ldots\ldots\ldots\ldots\ldots\ldots (5)$$

Throughout my research I will assume the exogenous vector X_t commodity price index (export), which is calculated based on the main export items of Ethiopia, the world oil price index (oilp) and the federal funds rate (fed).

$$X_t = \begin{bmatrix} \text{export} \\ \text{Oilp} \\ \text{Fed} \end{bmatrix} \quad \ldots\ldots\ldots\ldots\ldots\

$$\begin{bmatrix} \varepsilon_t^{GDP} \\ \varepsilon_t^{CPI} \\ \varepsilon_t^{M2} \\ \varepsilon_t^{T\text{-}BILL} \\ \varepsilon_t^{EXC} \end{bmatrix} = \begin{bmatrix} 1 & 0 & 0 & 0 & 0 \\ f_{21} & 1 & 0 & 0 & 0 \\ f_{31} & f_{32} & 1 & 0 & 0 \\ f_{41} & f_{42} & f_{43} & 1 & 0 \\ f_{51} & f_{52} & f_{53} & f_{54} & 1 \end{bmatrix} \begin{bmatrix} \mu_t^{GDP} \\ \mu_t^{CPI} \\ \mu_t^{M2} \\ \mu_t^{T\text{-}BILL} \\ \mu_t^{EXC} \end{bmatrix} \quad \text{..... (8)}$$

The above matrices shows the relationship between the reduced form errors and the structural disturbance .The recursive identification is based on the paper of Sims and zha (1998) and assumes no contemporaneous between monetary policy , money ,and the exchange rate .

The other alternative model is based on Kim and roubini (2000) which relaxes the above assumptions.

$$\begin{bmatrix} \varepsilon_t^{GDP} \\ \varepsilon_t^{CPI} \\ \varepsilon_t^{M2} \\ \varepsilon_t^{T\text{-}BILL} \\ \varepsilon_t^{EXC} \end{bmatrix} = \begin{bmatrix} 1 & 0 & 0 & 0 & 0 \\ f_{21} & 1 & 0 & 0 & 0 \\ f_{31} & f_{32} & 1 & f_{34} & 0 \\ 0 & 0 & f_{43} & 1 & f_{45} \\ f_{51} & f_{52} & f_{53} & f_{54} & 1 \end{bmatrix} \begin{bmatrix} \mu_t^{GDP} \\ \mu_t^{CPI} \\ \mu_t^{M2} \\ \mu_t^{T\text{-}BILL} \\ \mu_t^{EXC} \end{bmatrix} \quad \text{..... (9)}$$

The first two equations represent sluggish response of the real GDP and prices with respect to shocks to the nominal variables, money supply, repo rate and the nominal exchange rate. The third equation shows the money supply can be affected contemporaneously by shock in output, price and T-bill rate. The fourth equation shows that repo rate will not be affected contemporaneously by the shock of output and price. However it will be affected contemporaneously by money supply and exchange rate. At last, the last equation, shocks in all variables have a contemporaneous effect on the exchange rate.

In estimating these both VAR and SVAR methods, I have used eveiws7 soft ware package for computation. I used this software, because of access and convenient for me.

I have used a VAR length based on the traditional information criteria (Akaike information criteria (AIC) and the Schwartz information criteria), and the residuals were tested for

autocorrelation.[12] The Schwartz criterion suggests a lag of one order, and the Akaike criteria suggest a five lag; I tried to compare using both lags in my result. But because the result with five lag was not stable I did not use it in my analysis. Therefore, I have used only one lag based on the Schwartz criteria and the result was also stable.[13] This is also used in most empirical studies with limited data. Although Doing otherwise will give much impressive result , I did not because it means analyzing unreliable results and ending up in a wrong conclusion. in addition to the above reasons the schwartz criteria is consistent and select the more parsimonious model while the Akaike criteria is biased toward selecting an over parameterized model.[14]

[12] The test for lag selection and autocorrelation are presented in appendix 2 and 5 respectively.
[13] the VAR stability condition check is in appendix 4
[14] Walter enders , 2010, page 71-72

CHAPTER FIVE: EMPIRICAL RESULT

4.1 Empirical Analysis

One of the basic requirement, for inflation targeting to be successful, is there must be predictable and persistent relationship between the monetary policy instrument and inflation. Therefore, in this section i will present my empirical result of vector auto regression (VAR) and SVAR. Which have five endogenous variables and three exogenous variables[15], from the five endogenous variables; three of them are policy instrument variables. In the meantime, I will present the granger causality test on some selected channels of monetary transmission as a glimpse to the VAR analysis and the result are as follows:

Table 4 VAR granger causality

VAR Granger Causality/Block Exogeneity Wald Tests
Date: 07/18/12 Time: 09:58
Sample: 1998Q1 2011Q4
Included observations: 52

Dependent variable: D_L_GDP_NA

Excluded	Chi-sq	df	Prob.
D_L_CPI_NA	0.800140	2	0.6703
D_L_M2_NA	0.291649	2	0.8643
D_L_TBILL_NA	0.043500	2	0.9785
D_D_L_EXC_NA	0.078747	2	0.9614
All	1.036398	8	0.9980

Dependent variable: D_L_CPI_NA

Excluded	Chi-sq	df	Prob.
D_L_GDP_NA	0.785153	2	0.6753
D_L_M2_NA	16.49233	2	0.0003
D_L_TBILL_NA	0.382705	2	0.8258
D_D_L_EXC_NA	6.210478	2	0.0448
All	19.94792	8	0.0105

Sources: own regression using Eveiws7

[15] The trend of all these variables can be seen in appendix 1

The above table shows the result of bivariate and multivariate block granger causality test for price (CPI) and output (GDP) in Ethiopia. The result from this estimation shows that whether an endogenous variable can be treated as exogenous for each equation in the VAR. in a nut shell, the result suggest the overall significance of the policy variables to price and output.

Whilst, the joint probability shows the rejection of the null hypothesis for the multivariate case; the bivariate test for GDP shows that all the variables are not causing significant variation in GDP. This result is a little bit different from the case of other developing countries. In most case scenarios, both money supply and exchange rate are significant. However, this result is much the same with respect to the interest rate; that is it does not have a significant impact to the GDP. This is because the money and financial market is not developed. In addition to that, the join probability of the multivariate case was strongly rejected in the case of inflation (CPI). The bivariate test shows us, with the exception of the Treasury bill; all the policy instrument variables are causing significant variation in CPI. This finding is in line with my expectation and previous literatures.

To verify the above result, i have presented results for simple VAR and structural VAR in a similar way. Accordingly, first, I have presented the results from the simple VAR and in the next part I have presented results from structural VAR.

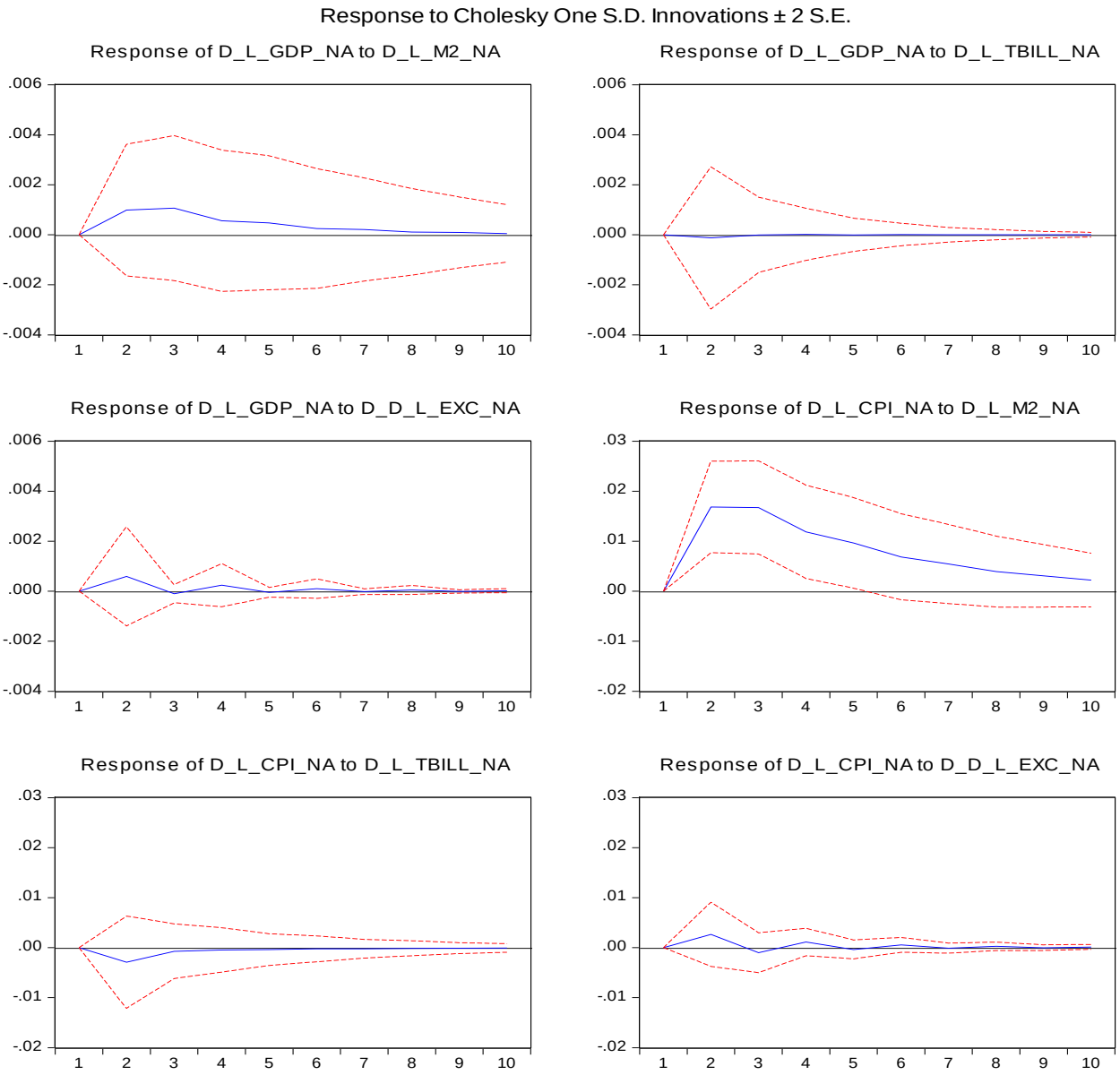
4.2 Results from Simple VAR

Another common way to interpret the relationship between monetary policy instruments and CPI or GDP using vector auto regression (VAR) is to estimate impulse response function and variance decomposition. Throughout this analysis, I have used a period of 10 quarters ahead in the analysis of impulse response function and the variance decompositions and confidence interval of 95 percent. This is represented by the dots in the impulse response graph.

An impulse response function traces the effect of one time shock to one of the innovations on current and future movement of the endogenous variable. For example, in my analysis, if there

is a predictable and strong relationship between future CPI or future GDP and monetary policy instrument, then it can be said that the lagged changes in the monetary policy instruments are economically significant in explaining future CPI or GDP.

Figure 1 Impulse Response for Simple VAR without exogenous variables



Sources: own result from eveiws7 estimation

The above figure, the quarterly impulse response, indicates how the monetary policy and other policy instrument variables affect CPI and GDP. Specifically, it shows how either CPI or GDP

responds to shocks or innovation in the other endogenous variables. The response of CPI, for two standard deviation shock in domestic money supply (M2) results in an increase in the consumer price index (CPI) from 0.2 to 1.7 percent following the shock and remains significant until the fifth quarter. However, there is a difference in the pace of the movement. From the first quarter to the third quarter the persistency is very high and reaches its climax at the third quarter which is 1.7 percent. From fourth quarter to the six quarter the persistency decreases but remains strong. However, from the seventh quarter afterwards the persistency decreases and reaches its minimum level which is 0.2 percent. On the other hand, the response of money supply (M2) to innovation in the consumer price index (CPI) is neutral in the medium and long term horizons. However, in the short term the money supply respond positively to the inflation rate. To sum up, if there is an expansionary monetary policy[16] , which works through the liquidity channel, it will increase the price level in the economy. In the contrary if there is an inflation pressure it is not followed by contractionary monetary measure. The later one can be seen in appendix 7.

The response of CPI to positive innovation in GDP[17] is, however, Contrary to what intuition or common sense would indicate, although they are not strong throughout ranging from 0.1 percent to 0.3 percent. This shows that increase in the productivity leads to an increase in the price level. The other important response of CPI is due to innovation or shocks in exchange rate. The response of consumer price index is not very strong both in short term and long term. Beside to that there is inconsistency in the result first the CPI increases, later decreases and in the long term it returns to what it where. It only stood from 0.3 percent when it rises and -0.1 when it falls. This finding was not as to my expectation taking in to account more 50 % of the component of CPI are imported commodity.

But this may be also due to the government intervention in those imported commodities. For instance, the government subsidizes the price of fuel, edible oil and sugar; which are some of the main components of consumer price index (CPI). When we see the importance of this

[16] when the government increases the spending and decreases taxation
[17] See appendix 7 for the detail

transmission mechanism with regard to inflation targeting there are some arguments between economists. While some of them argue that flexible exchange rate is consistent[18] with inflation targeting regime, others, nevertheless, think that it will create instability[19].

In the case of GDP, the socks in the policy instrument variables have less significance. Particularly shock in M2, do not have medium and long term effects. For instance, two standard deviation shocks in money supply affect slightly GDP in the short run by only 0.11 percent. Although the result is insignificant, it is in line with the theory that monetary expansion has an impact in the short run, but not in the medium and long term. In a similar manner shocks in t-bill and exchange rate do not have medium term and long term effect on GDP. May expectation here was to have negative relationship between GDP and the Treasury bill rate, through the investment channel.

The Variance decomposition results presented in the table below agree with the above empirical findings from the impulse responses. The 10 period forecast (2 years and half) show that, put together, the variances of output, money supply, exchange rate and interest rate account for less that 40 percent of variability in CPI until the second year (4 quarter). In other words, shocks or innovations to these endogenous variables explain less than 40 percent variation in the level of consumer price index (CPI) in the short and medium term horizons. This implies that the price behavior is characterized by apathy nature within these time horizons. However, this slightly changes after the sixth quarter when the innovation in GDP and money supply start to be strong.

[18] Bernanke et al. (1999), Mishkin and Savastano (2002) and De Gregorio, Tokman and Valdes (2005). Edward (2006)

[19] This connection between inflation targeting and floating exchange rates has led some analysts to argue that one of the costs of IT is the increase in exchange rate volatility.

Table 5 Variance decomposition for simple VAR without exogenous variables

Variance Decomposition of D_L_GDP_NA:						
Period	S.E.	D_L_GDP_NA	D_L_CPI_NA	D_L_M2_NA	D_L_TBILL_NA	D_D_L_EXC_NA
1	0.010015	100.0000	0.000000	0.000000	0.000000	0.000000
2	0.011968	98.72310	0.341510	0.681380	0.011354	0.242655
3	0.012752	97.83628	0.634476	1.299493	0.010015	0.219738
4	0.013068	97.63024	0.695464	1.420969	0.009662	0.243666
5	0.013206	97.48948	0.739201	1.522179	0.009468	0.239676
6	0.013263	97.45339	0.748842	1.544549	0.009411	0.243809
7	0.013288	97.42723	0.756317	1.564013	0.009376	0.243068
8	0.013299	97.42025	0.757937	1.568617	0.009365	0.243827
9	0.013304	97.41517	0.759238	1.572548	0.009359	0.243687
10	0.013306	97.41377	0.759508	1.573537	0.009356	0.243828
Variance Decomposition of D_L_CPI_NA:						
Period	S.E.	D_L_GDP_NA	D_L_CPI_NA	D_L_M2_NA	D_L_TBILL_NA	D_D_L_EXC_NA
1	0.032390	0.199974	99.80003	0.000000	0.000000	0.000000
2	0.038777	0.258595	79.84330	18.86524	0.564824	0.468038
3	0.042774	0.622180	67.62428	30.81832	0.493007	0.442214
4	0.044779	1.069937	62.84486	35.15984	0.460156	0.465205
5	0.046012	1.465488	59.96050	37.68360	0.443496	0.446921
6	0.046673	1.783697	58.54621	38.78850	0.433810	0.447785
7	0.047078	2.012136	57.65831	39.46038	0.428501	0.440673
8	0.047300	2.171204	57.18752	39.77621	0.425328	0.439736
9	0.047434	2.275476	56.89622	39.96749	0.423537	0.437276
10	0.047508	2.342775	56.73733	40.06072	0.422475	0.436708
Cholesky Ordering: D_L_GDP_NA D_L_CPI_NA D_L_M2_NA D_L_TBILL_NA D_D_L_EXC_NA						

Sources: Own estimation using Eveiws7

In a nut shell, a policy change in either exchange rate or interest rate is unlikely to bring desired change in price as the two accounted for less than 5 percent (jointly) in the short and medium term. Nevertheless, the change in the money supply and output has a prominent role in both short term and medium term. In the long term, although the trend gradually changes, CPI accounts for less than 57 percent of its variance. The contribution of exchange rate and interest rate to the variance remains minimal. In the other hand, output and money supply gained more

prominence. This further underscores the need for an increase in productivity and importance of the monetary transmission channel in checking inflation in the economy.

The variance decomposition of output[20] follows suit as it also totally drives its own variance in the first quarter. Putting together, the variance decomposition of price level, money supply, exchange rate and interest rate account for less that 3 percent of variability in GDP until the first second (8 quarter). There is no signee of change even in the long run, the combined effect of those variables remains well below 3 percent. When we see the individual effect, we see the contribution of money supply, interest rate and exchange rate to be meager. This is basically in line with what we found in the both the granger causality and impulse response results.

Therefore, a policy change in either exchange rate or interest rate is less likely to bring the most wanted increase in output as the two accounted for less than 1 percent in the short, medium and long term. However, the result with regard to money supply shows that a shock or innovation in money supply may boost up the output in both short term and medium term but still with less than 2 percent. This result again underscores the importance of monetary transmission channel. Although this result is in line with my expectation, it has a tendency to refute the neutrality of money[21] in the long run.

To verify my result from the simple VAR, I slightly changed the model by incorporating the exogenous variables and the result was basically the same. Specifically, the results with respect to the policy instruments are more or less the same. Although, there is a difference in the percentage point, the trend and the effectiveness of the transmission mechanism is the same. With respect to the exogenous variables we see that they have short and medium term impact on both price and output. However, in the long term they are pretty much neutral.[22]

[20] Appendix 8 variance decomposition for simple VAR without exogenous variable

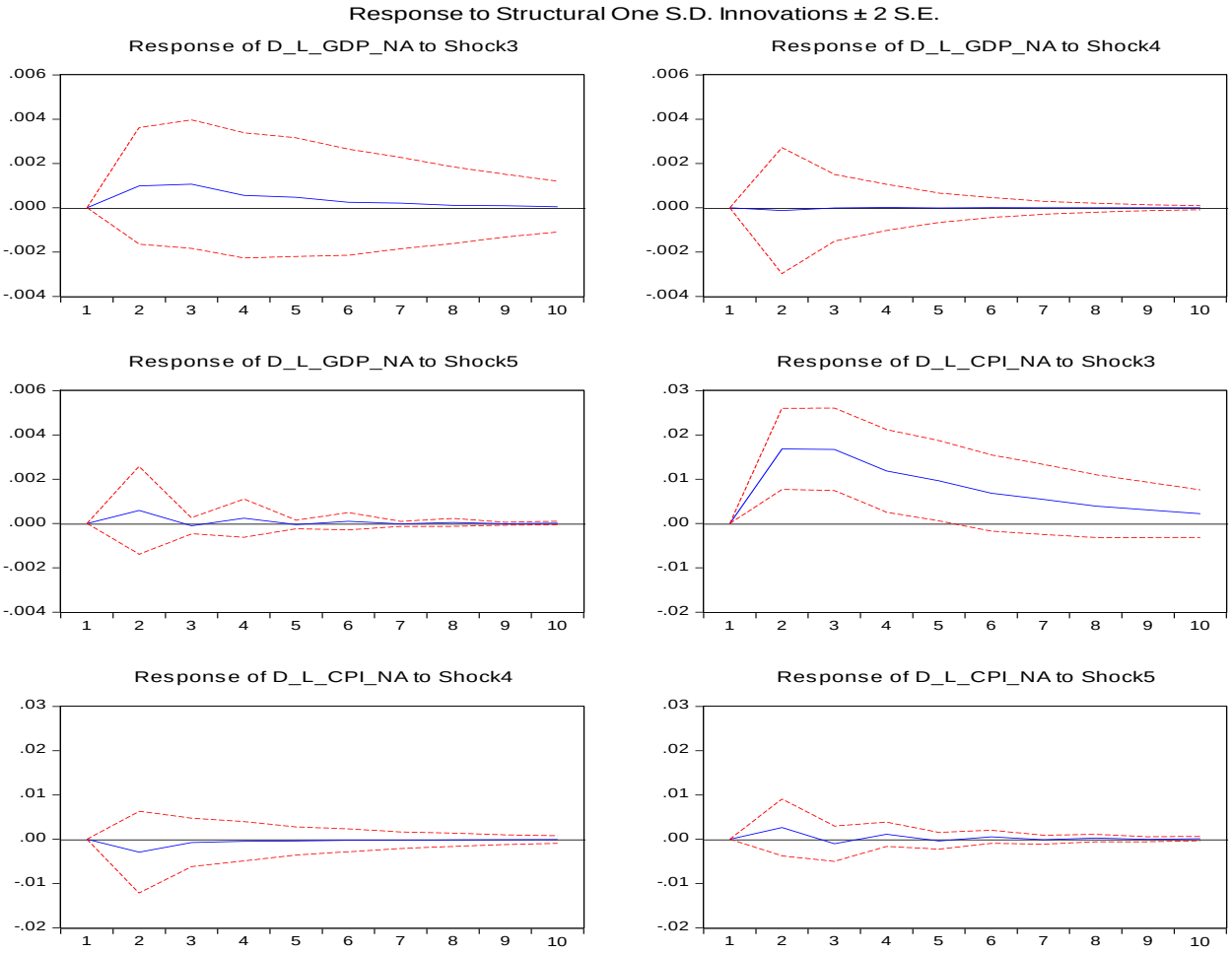
[21] According to this theory money cannot have a long term impact on real variables. However, they can be a solution not to be a problem by itself.

[22] All the result for this model can be seen in the appendix

4.3 Results from Structural VAR

To substantiate, the results I found in the simple VAR, I made an estimation of structural VAR and the following result are presented here below. In the analysis I have used both the recursive and no recursive ordering of structural VAR. However, because the hessian of the non recursive result is nearly singular I will present the result from the recursive ordering only. Furthermore, the analysis has the same format like what I have did in the simple VAR. That is, first without the exogenous variables and later on with exogenous variables.

Figure 2 Impulse Response for the structural VAR



Sources: own estimation using eveiws7

The above figure, the response to structural one standard division innovation, indicates how the monetary policy and other policy instrument variables affect CPI and GDP. Specifically, it

shows how either CPI or GDP responds to shocks or innovation in the other endogenous variables. The response of CPI, for structural one standard deviation innovation in domestic money supply (M2) or shock 3, results in an increase in the consumer price index (CPI) from 0.2 to 1.7 percent following the innovation and remains significant until the fifth quarter. However, there is a difference in the volatility of the movement. From the first quarter to the third quarter the persistency is very high and reaches its climax at the third quarter which is 1.7 percent. From fourth quarter to the six quarter the persistency decreases but remains strong. However, from the seventh quarter afterwards the persistency decreases and reaches its minimum level which is 0.2 percent.

Despite the effectiveness of the monetary transmission, the other policy instruments are less effective, particularly in the medium and long term. Although there is some movement in consequence to the fourth and fifth variable shocks. Specifically, if there is a shock4 or in t-bill CPI will decrease immediately and reaches -0.3 percent at the second quarter and returns to its previous level at the 6 quarter. The result shows us, if interest rate increases there is a tendency for the inflation rate to decrease. However, the result is not significant and very far from achieving the desired objective. Beside to that this policy measure will not have long lasting effect, because the response of CPI becomes neutral in the medium term and long term.

The impulse response for the structural one standard deviation in shock5 or exchange rate is very volatile. In effect CPI increased until the third quarter, decreased in the fourth quarter and increased again in the fifth quarter. However, after the fourth quarter the CPI returns to its previous level and remains stable. This finding is far from my expectation, because it is natural to see inflation increasing after a monetary devaluation and taking in to account 54 to 57 percent of CPI component are imported items.[23]

The other important response is the response of GDP, to the structural one standard deviation innovation in the policy instrument variables. The result is in line what I found in the simple VAR. That is with the exception of the shock in money supply, a shock in the other policy

[23] Ethiopian central statistics authority 2006 base of CPI

instrument variables do not have significant impact in the volatility of GDP. Beside to the above finding, the recursive structural VAR without exogenous variables, I have also estimated VAR with exogenous variables and came up with the same results and the result is presented in the appendix part.

Table 6 Variance decomposition for structural VAR

Variance Decomposition of D_L_GDP_NA:						
Period	S.E.	Shock1	Shock2	Shock3	Shock4	Shock5
1	0.010015	100.0000	0.000000	0.000000	0.000000	0.000000
2	0.011968	98.72310	0.341510	0.681380	0.011354	0.242655
3	0.012752	97.83628	0.634476	1.299493	0.010015	0.219738
4	0.013068	97.63024	0.695464	1.420969	0.009662	0.243666
5	0.013206	97.48948	0.739201	1.522179	0.009468	0.239676
6	0.013263	97.45339	0.748842	1.544549	0.009411	0.243810
7	0.013288	97.42723	0.756317	1.564013	0.009376	0.243068
8	0.013299	97.42025	0.757937	1.568617	0.009365	0.243827
9	0.013304	97.41517	0.759238	1.572548	0.009359	0.243687
10	0.013306	97.41377	0.759508	1.573537	0.009356	0.243828
Variance Decomposition of D_L_CPI_NA:						
Period	S.E.	Shock1	Shock2	Shock3	Shock4	Shock5
1	0.032390	0.199974	99.80003	8.11E-34	4.53E-31	0.000000
2	0.038777	0.258595	79.84330	18.86524	0.564824	0.468038
3	0.042774	0.622180	67.62428	30.81832	0.493007	0.442214
4	0.044779	1.069937	62.84486	35.15984	0.460156	0.465205
5	0.046012	1.465488	59.96050	37.68360	0.443496	0.446921
6	0.046673	1.783697	58.54621	38.78850	0.433810	0.447785
7	0.047078	2.012136	57.65831	39.46038	0.428501	0.440673
8	0.047300	2.171204	57.18752	39.77621	0.425328	0.439736
9	0.047434	2.275476	56.89622	39.96749	0.423537	0.437276
10	0.047508	2.342775	56.73733	40.06072	0.422475	0.436708
Factorization: Structural						

Sources: own estimation using eviews7

The Variance decomposition results presented in the table above agree with the above empirical findings from the impulse responses and the simple VAR. in both short term and long

term the variance decomposition of GDP is explained by less than 3 Percent by the other policy instrument variables putting together. This finding confirms what we found in the simple VAR and justifies the neutrality of money in affecting real economic variables. On the other hand, the variance decomposition of CPI shows the variability is affected significantly by the variance of money supply. This result is also in line with what I found in the simple VAR and some of the findings of my literature review.

Therefore, policy measures in exchange rate and the interest rate will not have the desired effect of lowering inflation rate. Rather, it would be advisable to control the supply of money or the money in the circulation. In a nut shell, both findings (simple VAR and structural VAR) show that beside to the monetary transmission, the interest rate and exchange rate transmission mechanisms are less effective in Ethiopia.

The result after including the exogenous variables is also basically the same although there is a difference in the percentage point. Specifically, the response of CPI to one standard deviation structural shock in money supply will increase the inflation rate by 1.17 percent in the second quarter and decrease sharply after the third quarter. While the shock in the other policy instrument variables is insignificant for inflation. Likewise, the response of GDP to shocks in money supply increases GDP until the third quarter with 0.06 percent. However, after the third quarter it remains neutral. On the other hand, the shock in t-bill rate and exchange rate are well below 0.05 percent and -0.02 percent respectively.[24]

[24] The detail estimation is presented in appendix 19 and 20

CHAPTER FIVE: CONCLUSION AND RECOMMENDATION

5.1 Conclusion

In my paper, I have tried to see the applicability of inflation targeting in Ethiopia using quarterly data from 1998 Q1 to 2011 Q4. Although I have discussed all the requirements of inflation targeting in developing countries in my literature part, I concentrated only on the predictability of the transmission mechanism, since this is one of the main requirement in order to adopt inflation targeting to any country's monetary policy. In order to achieve this objective, i have used the simple VAR analysis and structural VAR (in both recursive and non recursive order of variables). In the process i tried to analyze the granger causality, impulse response and the variance decomposition of the simple VAR and the structural VAR.

Both the bivariate and multivariate granger causality tests shows that the money supply (M2) and the nominal effective exchange rate (EXC) in the economy causes the variation in the level of consumer price index (CPI) significantly; However , the treasury bill rate (T-bill) does not cause the variation in the price level (CPI). On the other hand, i found that the variation in the output level (GDP) is significantly caused by money supply (M2) and consumer price index (CPI).However; it was not significantly caused by nominal exchange rate (EXC) and the Treasury bill rate (T-bill).

We can deduce from the impulse response that, the response of consumer price index (CPI) to its own shock, although it is les persistent in the long run, in both the short term and medium term it is very strong. The response of consumer price index (CPI) to shocks in exchange rate (exchange rate channel) and the Treasury bill rate (interest rate channel) are less significant and remain the same in both short term and long term. This result is substantiated by the result I found in the variance decomposition of consumer price index (CPI). Where the variance of consumer price index (CPI) , is explained by exchange rate and t-bill rate by less than 1 percent . In the same manner, both policy instrument variables were found to be less effective in driving the GDP in the economy. Although it raises doubt, when the policy makers mainly depend on

them as a means for achieving effective inflation targeting regime, this does not mean that they are totally ineffective in affecting the monetary transmission channels.

On the other hand, the bond between consumer price index (CPI) and money supply (M2) were found to be robust in both the short term and long term. Beside to that, the bond between consumer price index and growth in GDP were found to be significant, in both the impulse response and variance decomposition .The significance of the money supply transmission channel, taking in to account its positive relationship with consumer price index, shows that the effect of the money supply shock transfers to the overall economy through the price level. In a nut shell, change in GDP and change in the money supply account for more than 40 percent of variance in consumer price index (CPI) in the medium term and long term horizon.

Therefore, based on the result we can conclude that it is very difficult to have predictable and significant relationship among the policy instrument variables, GDP and CPI. As I have mentioned in the introduction part, the main objective of this paper was to see if there is a predictable relationship among the mentioned variables. With the exception of money supply there is no predictable and significant relationship. in the case of exchange rate, ironically there is a price puzzle and may be due to the inconsistency in the decision of policy makers[25] . This will make it difficult for the national bank to introduce full-fledged inflation targeting. Because , policy measures in t-bill rate and the exchange rate will not bring the desired objective of stabilizing inflation .

5.2 Recommendation

Taking in to account the need to have predictable relationship between the policy instrument variables (money supply , interest rate , and exchange rate) with the consumer price index and in view of the above findings it is not the right time for Ethiopia to adopt the full fledged inflation targeting monetary policy . However, this does not mean that any type of inflation

[25] The government intervenes in the market trough price ceiling in 2010 and abandons it in 2011. The government subsidizes fuel, oil, sugar, wheat and cement starting from 2010 and stopped. These policies inconsistency have a great role in the price puzzle.

targeting cannot be effective in Ethiopia. Rather, Ethiopia can apply inflation targeting implicitly[26].

Nevertheless, in order to apply the implicit inflation targeting or limited version of inflation targeting, further research in this topic is required. For instance, it would be good to see the effectiveness of the expectation channel, the credit channel and the treat of fiscal dominance. In addition to the above, it would be advisable for the national bank to decrease its intervention in the exchange rate determination by making it driven by market (although in theory it is market driven). Furthermore, the government should decrease the subsidies which distort the actual market price of commodities.

[26] Implicit inflation targeting can be defined as a period under which inflation targets are announced to the public, but not the regime and its details as such. It involves country acting as if inflation targeting were in place without a formal adoption of the regime. Typically, the central bank would also have other intermediate targets, as Turkey did between 2002-2005 in the form of monetary targets.

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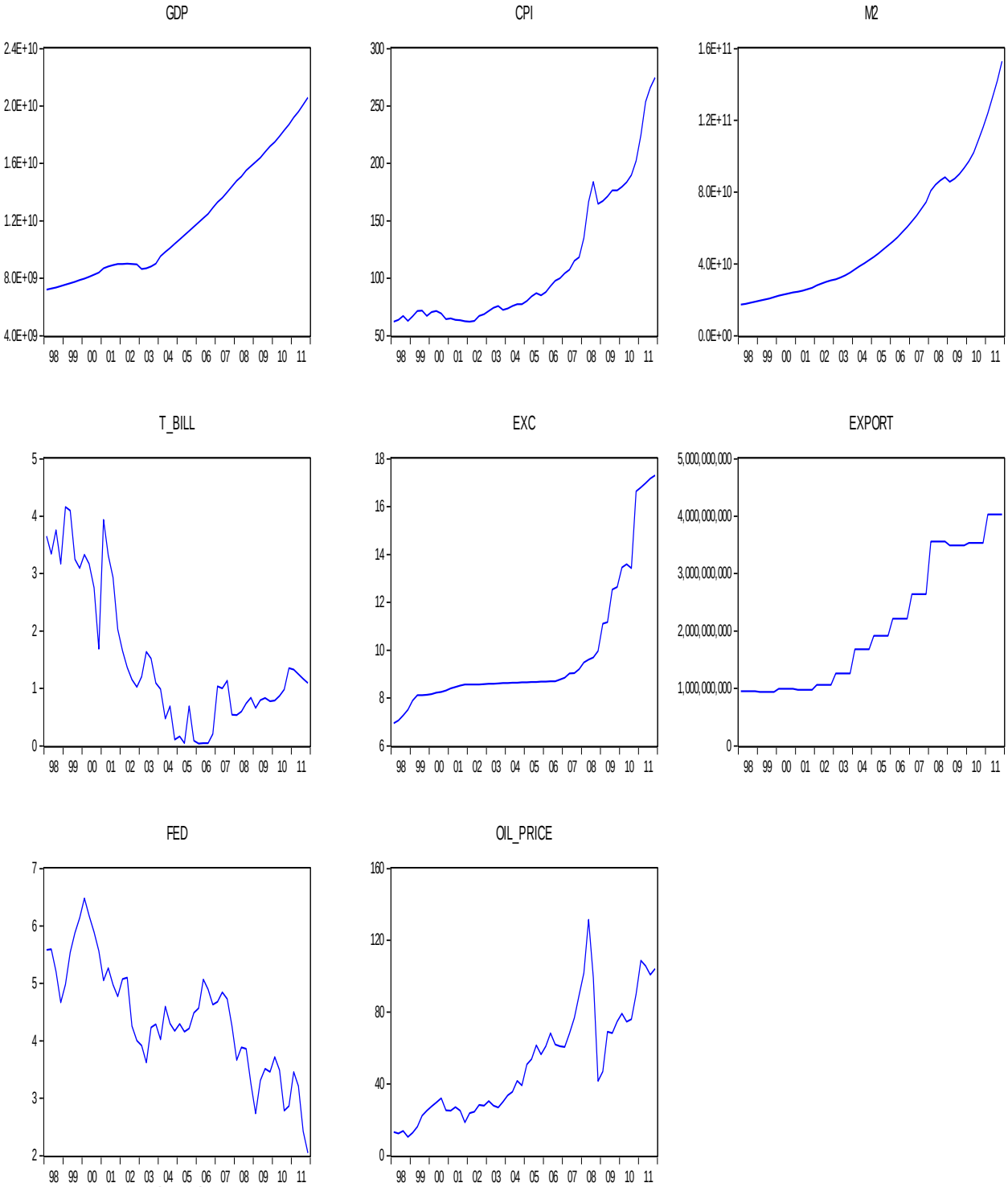
APENDIXES

APPENDIX

Note : all the appendixes source is my own estimation using Eviews7

APPENDIX 1 description of the data



Source: own estimation

Case 1: Estimation of simple VAR with Endogenous Variables and constant

APPENDIX 2 VAR lag selection criteria

VAR Lag Order Selection Criteria
Endogenous variables: D_L_GDP_NA D_L_CPI_NA D_L_M2_NA D_L_TBILL_NA D_D_L_EXC_NA
Exogenous variables: C
Date: 07/17/12 Time: 12:48
Sample: 1998Q1 2011Q4
Included observations: 49

Lag	LogL	LR	FPE	AIC	SC	HQ
0	389.5529	NA	1.05e-13	-15.69604	-15.50299	-15.62280
1	448.9762	104.2940	2.59e-14*	-17.10107	-15.94281*	-16.66163*
2	466.0516	26.48420	3.70e-14	-16.77761	-14.65414	-15.97197
3	485.8484	26.66507	4.98e-14	-16.56524	-13.47655	-15.39340
4	530.7751	51.34479*	2.62e-14	-17.37857	-13.32467	-15.84053
5	559.6272	27.08571	3.05e-14	-17.53580*	-12.51669	-15.63156

* indicates lag order selected by the criterion
LR: sequential modified LR test statistic (each test at 5% level)
FPE: Final prediction error
AIC: Akaike information criterion
SC: Schwarz information criterion
HQ: Hannan-Quinn information criterion

APPENDIX 3 Vector Autoregression estimates

Vector Autoregression Estimates
Date: 07/17/12 Time: 09:41
Sample (adjusted): 1998Q4 2011Q4
Included observations: 53 after adjustments
Standard errors in ( ) & t-statistics in [ ]

	D_L_GDP_NA	D_L_CPI_NA	D_L_M2_NA	D_L_TBILL_NA	D_D_L_EXC_NA
D_L_GDP_NA(-1)	0.618910	-0.294345	0.110374	-2.124754	-0.147311
	(0.11716)	(0.37890)	(0.16045)	(7.40815)	(0.46546)
	[5.28276]	[-0.77683]	[0.68791]	[-0.28681]	[-0.31649]
D_L_CPI_NA(-1)	-0.025974	0.329536	0.046995	2.764885	-0.244896
	(0.03638)	(0.11765)	(0.04982)	(2.30014)	(0.14452)
	[-0.71405]	[2.80110]	[0.94333]	[1.20205]	[-1.69455]

D_L_M2_NA(-1)	0.086430	1.311468	0.602235	-2.070378	0.383624
	(0.09876)	(0.31939)	(0.13525)	(6.24460)	(0.39235)
	[0.87519]	[4.10613]	[4.45279]	[-0.33155]	[0.97775]
D_L_TBILL_NA(-1)	-0.000301	-0.005082	-0.000220	-0.139242	0.002595
	(0.00226)	(0.00729)	(0.00309)	(0.14260)	(0.00896)
	[-0.13361]	[-0.69676]	[-0.07110]	[-0.97643]	[0.28967]
D_D_L_EXC_NA(-1)	0.015543	0.069940	0.002485	0.268481	-0.678051
	(0.02610)	(0.08442)	(0.03575)	(1.65049)	(0.10370)
	[0.59548]	[0.82850]	[0.06951]	[0.16267]	[-6.53846]
C	0.004860	-0.027605	0.012924	0.019703	-0.005968
	(0.00370)	(0.01197)	(0.00507)	(0.23401)	(0.01470)
	[1.31321]	[-2.30635]	[2.54988]	[0.08420]	[-0.40591]
R-squared	0.434577	0.502503	0.456626	0.049626	0.502245
Adj. R-squared	0.374426	0.449578	0.398820	-0.051478	0.449292
Sum sq. resids	0.004714	0.049308	0.008842	18.84865	0.074409
S.E. equation	0.010015	0.032390	0.013716	0.633273	0.039789
F-statistic	7.224734	9.494595	7.899305	0.490838	9.484798
Log likelihood	171.9750	109.7650	155.3082	-47.80669	98.86062
Akaike AIC	-6.263207	-3.915661	-5.634270	2.030441	-3.504174
Schwarz SC	-6.040155	-3.692609	-5.411218	2.253493	-3.281122
Mean dependent	0.019387	0.027150	0.039904	-0.024507	-0.000299
S.D. dependent	0.012662	0.043658	0.017690	0.617577	0.053617
Determinant resid covariance (dof adj.)		1.05E-14			
Determinant resid covariance		5.78E-15			
Log likelihood		492.7741			
Akaike information criterion		-17.46318			
Schwarz criterion		-16.34792			

APPENDIX 4 VAR Stability Condition check

Roots of Characteristic Polynomial
Endogenous variables: D_L_GDP_NA D_L_CPI_NA D_L_M2_NA D_L_TBILL_NA D_D_L_EXC_NA
Exogenous variables: C
Lag specification: 1 1
Date: 07/17/12 Time: 09:53

Root	Modulus
0.744054	0.744054
-0.656254	0.656254
0.654794	0.654794
-0.095638	0.095638
0.086431	0.086431

No root lies outside the unit circle.
VAR satisfies the stability condition.

APPENDIX 5 Portmanteau test of autocorrelations

VAR Residual Portmanteau Tests for Autocorrelations
Null Hypothesis: no residual autocorrelations up to lag h
Date: 07/17/12 Time: 09:47
Sample: 1998Q1 2011Q4
Included observations: 53

Lags	Q-Stat	Prob.	Adj Q-Stat	Prob.	df
1	9.407328	NA*	9.588239	NA*	NA*
2	30.11404	0.2200	31.10698	0.1855	25
3	53.31540	0.3480	55.70041	0.2690	50
4	74.33892	0.4999	78.44014	0.3703	75
5	91.98153	0.7038	97.92053	0.5402	100
6	125.7602	0.4641	136.0114	0.2361	125
7	146.5444	0.5645	159.9583	0.2739	150
8	183.4680	0.3152	203.4462	0.0694	175
9	203.3654	0.4205	227.4136	0.0892	200
10	238.6195	0.2544	270.8662	0.0196	225
11	263.2748	0.2699	301.9788	0.0136	250
12	282.5394	0.3643	326.8819	0.0172	275

*The test is valid only for lags larger than the VAR lag order.
df is degrees of freedom for (approximate) chi-square distribution

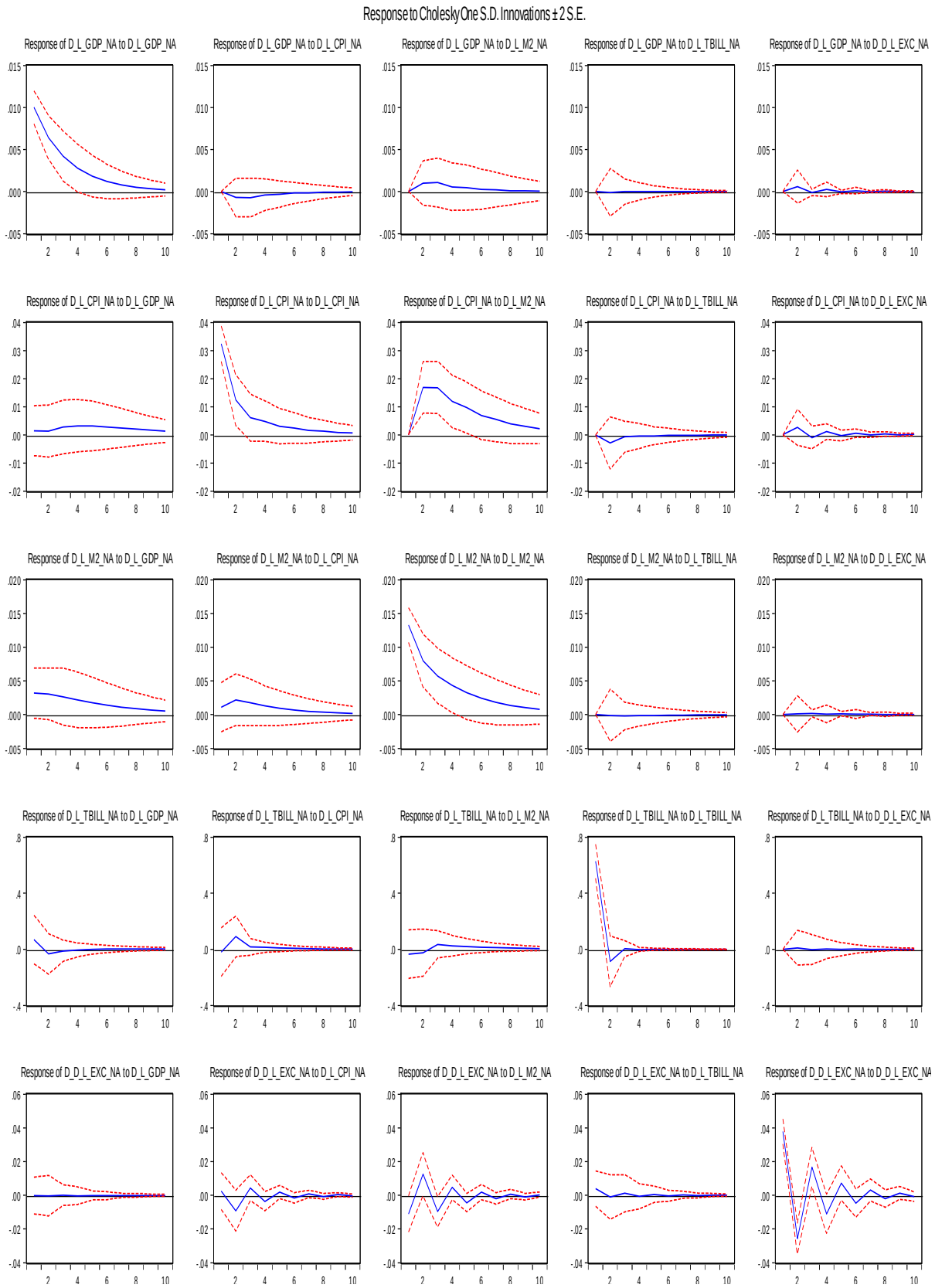
APPENDIX 6 Serial Correlation LM tests

VAR Residual Serial Correlation LM Tests
Null Hypothesis: no serial correlation at lag order h
Date: 07/17/12 Time: 10:00
Sample: 1998Q1 2011Q4
Included observations: 53

Lags	LM-Stat	Prob
1	24.50335	0.4905
2	28.96698	0.2653
3	26.27434	0.3931
4	22.43810	0.6103
5	31.11786	0.1851
6	39.96787	0.0294
7	25.68202	0.4247
8	47.30703	0.0045
9	22.97891	0.5788
10	49.63474	0.0024
11	35.26935	0.0834
12	24.97558	0.4637

Probs from chi-square with 25 df.

APPENDIX 7 impulse response



APPENDIX 8 Variance Decomposition

Variance Decomposition of D_L_GDP_NA:

Period	S.E.	D_L_GDP_NA	D_L_CPI_NA	D_L_M2_NA	D_L_TBILL_NA	D_D_L_EXC_NA
1	0.010015	100.0000	0.000000	0.000000	0.000000	0.000000
2	0.011968	98.72310	0.341510	0.681380	0.011354	0.242655
3	0.012752	97.83628	0.634476	1.299493	0.010015	0.219738
4	0.013068	97.63024	0.695464	1.420969	0.009662	0.243666
5	0.013206	97.48948	0.739201	1.522179	0.009468	0.239676
6	0.013263	97.45339	0.748842	1.544549	0.009411	0.243809
7	0.013288	97.42723	0.756317	1.564013	0.009376	0.243068
8	0.013299	97.42025	0.757937	1.568617	0.009365	0.243827
9	0.013304	97.41517	0.759238	1.572548	0.009359	0.243687
10	0.013306	97.41377	0.759508	1.573537	0.009356	0.243828

Variance Decomposition of D_L_CPI_NA:

Period	S.E.	D_L_GDP_NA	D_L_CPI_NA	D_L_M2_NA	D_L_TBILL_NA	D_D_L_EXC_NA
1	0.032390	0.199974	99.80003	0.000000	0.000000	0.000000
2	0.038777	0.258595	79.84330	18.86524	0.564824	0.468038
3	0.042774	0.622180	67.62428	30.81832	0.493007	0.442214
4	0.044779	1.069937	62.84486	35.15984	0.460156	0.465205
5	0.046012	1.465488	59.96050	37.68360	0.443496	0.446921
6	0.046673	1.783697	58.54621	38.78850	0.433810	0.447785
7	0.047078	2.012136	57.65831	39.46038	0.428501	0.440673
8	0.047300	2.171204	57.18752	39.77621	0.425328	0.439736
9	0.047434	2.275476	56.89622	39.96749	0.423537	0.437276
10	0.047508	2.342775	56.73733	40.06072	0.422475	0.436708

Variance Decomposition of D_L_M2_NA:

Period	S.E.	D_L_GDP_NA	D_L_CPI_NA	D_L_M2_NA	D_L_TBILL_NA	D_D_L_EXC_NA
1	0.013716	5.390795	0.645921	93.96328	0.000000	0.000000
2	0.016316	7.362339	2.266784	90.36138	0.006160	0.003336
3	0.017591	8.568698	2.979117	88.41900	0.019801	0.013383
4	0.018293	9.341785	3.248410	87.36894	0.025979	0.014887
5	0.018686	9.847440	3.368228	86.73796	0.028857	0.017512
6	0.018909	10.17129	3.418052	86.36217	0.030376	0.018116
7	0.019036	10.37695	3.441476	86.13154	0.031132	0.018910
8	0.019108	10.50452	3.451303	85.99348	0.031547	0.019150
9	0.019149	10.58279	3.455920	85.91013	0.031761	0.019399
10	0.019172	10.62994	3.457781	85.86091	0.031880	0.019489

Variance Decomposition of D_L_TBILL_NA:

Period	S.E.	D_L_GDP_NA	D_L_CPI_NA	D_L_M2_NA	D_L_TBILL_NA	D_D_L_EXC_NA
1	0.633273	1.206052	0.105760	0.309588	98.37860	0.000000

2	0.647008	1.425186	2.067940	0.452985	96.02912	0.024773
3	0.648269	1.452160	2.121397	0.740248	95.66011	0.026089
4	0.648905	1.455680	2.161000	0.883045	95.47343	0.026841
5	0.649287	1.454193	2.175706	0.981726	95.36139	0.026980
6	0.649492	1.453586	2.184310	1.033600	95.30134	0.027162
7	0.649617	1.454028	2.187898	1.066354	95.26455	0.027167
8	0.649688	1.455006	2.189964	1.083816	95.24400	0.027214
9	0.649731	1.456019	2.190845	1.094477	95.23145	0.027211
10	0.649755	1.456880	2.191347	1.100214	95.22433	0.027224

Variance Decomposition of D_D_L_EXC_NA:

Period	S.E.	D_L_GDP_NA	D_L_CPI_NA	D_L_M2_NA	D_L_TBILL_NA	D_D_L_EXC_NA
1	0.039789	0.002676	0.409369	7.716800	0.996497	90.87466
2	0.049883	0.005043	3.722121	11.19266	0.679422	84.40076
3	0.053717	0.004357	3.892644	12.94668	0.634135	82.52219
4	0.055163	0.007546	4.131173	12.98747	0.617051	82.25676
5	0.055843	0.008020	4.146495	13.29920	0.610523	81.93576
6	0.056101	0.009971	4.190119	13.28745	0.607702	81.90476
7	0.056229	0.010601	4.191056	13.35434	0.606527	81.83748
8	0.056276	0.011511	4.199838	13.34867	0.606007	81.83397
9	0.056300	0.011880	4.199614	13.36379	0.605784	81.81894
10	0.056309	0.012248	4.201431	13.36200	0.605685	81.81864

Cholesky Ordering: D_L_GDP_NA D_L_CPI_NA D_L_M2_NA D_L_TBILL_NA D_D_L_EXC_NA

Case 2: Estimation of Simple VAR with Endogenous and Exogenous variables.

APPENDIX 9 Lag length selection criteria

VAR Lag Order Selection Criteria
Endogenous variables: D_L_GDP_NA D_L_CPI_NA D_L_M2_NA D_L_TBILL_NA D_D_L_EXC_NA
Exogenous variables: C D_L_EXPORT_NA D_L_FED_NA D_L_OILP_NA
Date: 07/17/12 Time: 12:44
Sample: 1998Q1 2011Q4
Included observations: 49

Lag	LogL	LR	FPE	AIC	SC	HQ
0	402.3200	NA	1.15e-13	-15.60490	-14.83272	-15.31194
1	468.5269	108.0930	2.18e-14	-17.28681	-15.54943*	-16.62765*
2	486.3143	25.41048	3.11e-14	-16.99242	-14.28982	-15.96706
3	511.4561	30.78593	3.53e-14	-16.99821	-13.33039	-15.60664
4	561.2133	50.77268*	1.65e-14*	-18.00871	-13.37568	-16.25094
5	593.4613	26.32486	1.88e-14	-18.30454*	-12.70630	-16.18058

* indicates lag order selected by the criterion
LR: sequential modified LR test statistic (each test at 5% level)

FPE: Final prediction error
AIC: Akaike information criterion
SC: Schwarz information criterion
HQ: Hannan-Quinn information criterion

APPENDIX 10 VAR estimates including exogenous variables

Vector Autoregression Estimates
Date: 07/17/12 Time: 12:52
Sample (adjusted): 1998Q4 2011Q4
Included observations: 53 after adjustments
Standard errors in ( ) & t-statistics in [ ]

	D_L_GDP_NA	D_L_CPI_NA	D_L_M2_NA	D_L_TBILL_NA	D_D_L_EXC_NA
D_L_GDP_NA(-1)	0.625836	-0.274854	0.086606	-1.738581	-0.167173
	(0.12196)	(0.34249)	(0.14086)	(7.80802)	(0.49024)
	[5.13167]	[-0.80251]	[0.61484]	[-0.22267]	[-0.34100]
D_L_CPI_NA(-1)	-0.032447	0.429687	0.035649	3.101664	-0.253861
	(0.03961)	(0.11124)	(0.04575)	(2.53596)	(0.15922)
	[-0.81916]	[3.86279]	[0.77922]	[1.22307]	[-1.59437]
D_L_M2_NA(-1)	0.061086	1.025876	0.503385	-1.959955	0.471914
	(0.10886)	(0.30572)	(0.12574)	(6.96980)	(0.43761)
	[0.56112]	[3.35555]	[4.00343]	[-0.28121]	[1.07839]
D_L_TBILL_NA(-1)	-0.000491	-0.000713	-0.000165	-0.129893	0.002110
	(0.00235)	(0.00659)	(0.00271)	(0.15032)	(0.00944)
	[-0.20923]	[-0.10816]	[-0.06082]	[-0.86410]	[0.22355]
D_D_L_EXC_NA(-1)	0.012875	0.007232	-0.032074	0.465229	-0.665800
	(0.02766)	(0.07768)	(0.03195)	(1.77102)	(0.11120)
	[0.46543]	[0.09310]	[-1.00388]	[0.26269]	[-5.98760]
C	0.004814	-0.026788	0.012501	0.026249	-0.006100
	(0.00377)	(0.01060)	(0.00436)	(0.24157)	(0.01517)
	[1.27588]	[-2.52811]	[2.86846]	[0.10866]	[-0.40218]
D_L_EXPORT_NA	0.036838	0.094064	0.159810	-1.206493	-0.064064
	(0.03391)	(0.09522)	(0.03916)	(2.17075)	(0.13629)
	[1.08649]	[0.98788]	[4.08081]	[-0.55580]	[-0.47005]
D_L_FED_NA	-0.007495	-0.032146	0.002403	-0.184119	0.020393
	(0.01832)	(0.05146)	(0.02116)	(1.17319)	(0.07366)
	[-0.40904]	[-0.62466]	[0.11351]	[-0.15694]	[0.27685]
D_L_OILP_NA	-0.001687	0.103130	0.016231	0.078161	-0.014556
	(0.00977)	(0.02744)	(0.01129)	(0.62555)	(0.03928)

	[-0.17268]	[3.75852]	[1.43823]	[0.12495]	[-0.37061]
R-squared	0.452606	0.636847	0.625842	0.056778	0.506689
Adj. R-squared	0.353080	0.570820	0.557813	-0.114716	0.416996
Sum sq. resids	0.004564	0.035993	0.006088	18.70678	0.073745
S.E. equation	0.010184	0.028601	0.011763	0.652038	0.040939
F-statistic	4.547607	9.645149	9.199670	0.331079	5.649160
Log likelihood	172.8337	118.1063	165.1958	-47.60649	99.09829
Akaike AIC	-6.182404	-4.117220	-5.894183	2.136094	-3.399935
Schwarz SC	-5.847826	-3.782642	-5.559605	2.470672	-3.065357
Mean dependent	0.019387	0.027150	0.039904	-0.024507	-0.000299
S.D. dependent	0.012662	0.043658	0.017690	0.617577	0.053617

Determinant resid covariance (dof adj.)	7.03E-15
Determinant resid covariance	2.77E-15
Log likelihood	512.2243
Akaike information criterion	-17.63110
Schwarz criterion	-15.95822

APPENDIX 11 Stability condition check

Roots of Characteristic Polynomial
Endogenous variables: D_L_GDP_NA D_L_CPI_NA D_L_M2_NA D_L_TBILL_NA D_D_L_EXC_NA
Exogenous variables: C D_L_EXPORT_NA D_L_FED_NA D_L_OILP_NA
Lag specification: 1 1
Date: 07/17/12 Time: 13:02

Root	Modulus
0.668144 - 0.045726i	0.669706
0.668144 + 0.045726i	0.669706
-0.640698	0.640698
0.194491	0.194491
-0.126864	0.126864

No root lies outside the unit circle.
VAR satisfies the stability condition.

APPENDIX 12 VAR residual portmanteau test

VAR Residual Portmanteau Tests for Autocorrelations
Null Hypothesis: no residual autocorrelations up to lag h
Date: 07/17/12 Time: 13:05
Sample: 1998Q1 2011Q4
Included observations: 53

Lags	Q-Stat	Prob.	Adj Q-Stat	Prob.	df
1	12.11925	NA*	12.35231	NA*	NA*
2	32.78037	0.1367	33.82368	0.1117	25
3	50.81428	0.4413	52.93961	0.3614	50
4	72.53761	0.5591	76.43628	0.4321	75
5	92.07591	0.7014	98.00982	0.5376	100
6	117.1264	0.6795	126.2583	0.4517	125
7	138.3332	0.7432	150.6922	0.4688	150
8	159.0105	0.8013	175.0454	0.4848	175
9	179.6018	0.8469	199.8486	0.4897	200
10	211.6680	0.7290	239.3720	0.2436	225
11	228.2874	0.8341	260.3442	0.3135	250
12	247.3718	0.8832	285.0142	0.3263	275

*The test is valid only for lags larger than the VAR lag order.
df is degrees of freedom for (approximate) chi-square distribution
*df and Prob. may not be valid for models with exogenous variables

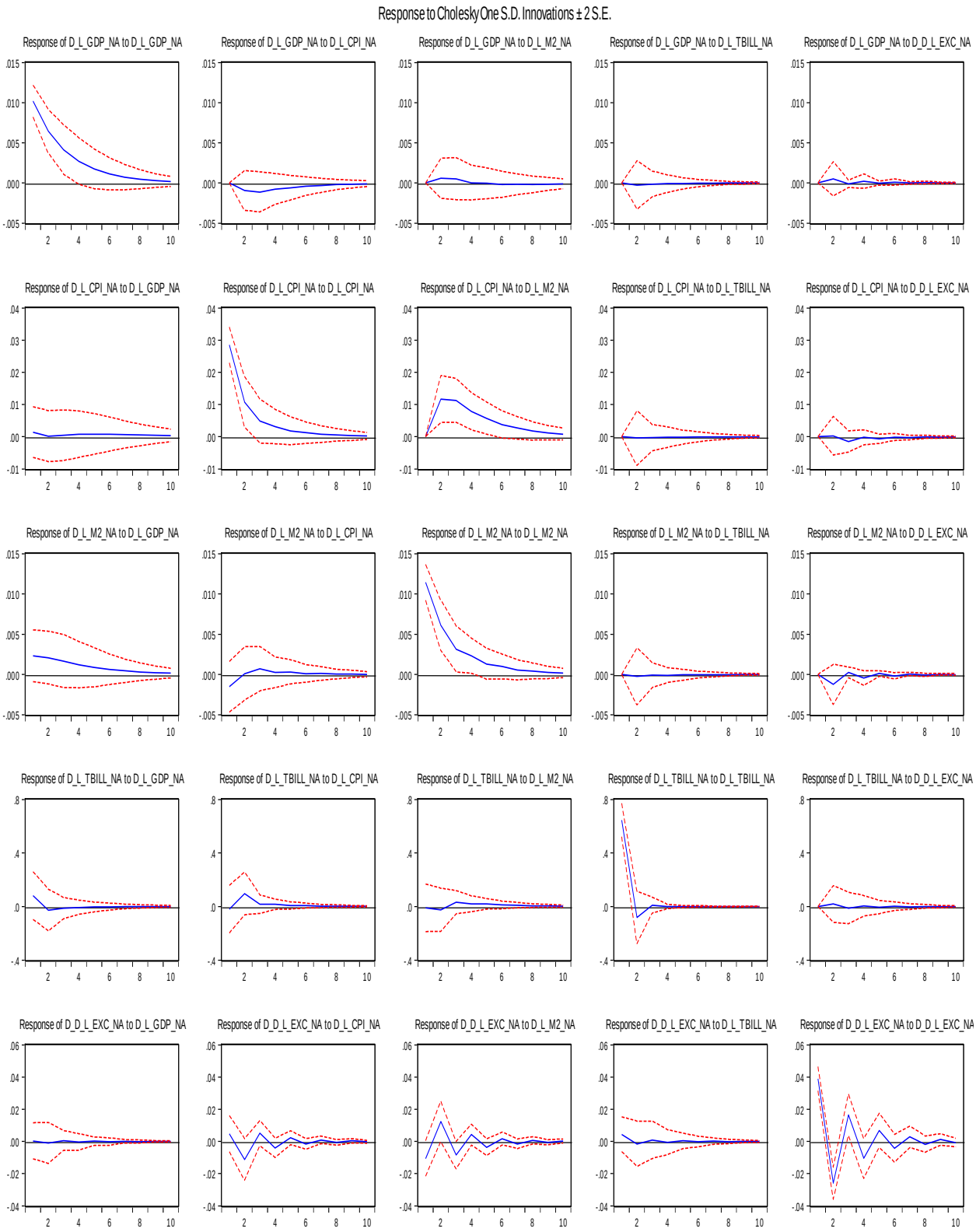
APPENDIX 13 VAR residual serial correlation tests

VAR Residual Serial Correlation LM Tests
Null Hypothesis: no serial correlation at lag order h
Date: 07/17/12 Time: 13:08
Sample: 1998Q1 2011Q4
Included observations: 53

Lags	LM-Stat	Prob
1	30.00291	0.2242
2	32.45769	0.1452
3	19.84058	0.7551
4	26.49439	0.3816
5	27.37382	0.3375
6	33.72851	0.1138
7	26.05946	0.4044
8	29.76807	0.2331
9	28.69702	0.2768
10	47.63699	0.0041
11	26.33012	0.3902
12	29.56833	0.2409

Probs from chi-square with 25 df.

APPENDIX 14 Impulse Response for case 2



APPENDIX 15 Variance Decomposition for case 2

Variance Decomposition of D_L_GDP_NA:

Period	S.E.	D_L_GDP_NA	D_L_CPI_NA	D_L_M2_NA	D_L_TBILL_NA	D_D_L_EXC_NA
1	0.010184	100.0000	0.000000	0.000000	0.000000	0.000000
2	0.012110	98.94814	0.614080	0.219370	0.046424	0.171981
3	0.012863	98.11301	1.313855	0.359005	0.053758	0.160370
4	0.013166	97.83331	1.589673	0.343131	0.054915	0.178966
5	0.013295	97.65158	1.778977	0.337927	0.055598	0.175916
6	0.013350	97.55147	1.855954	0.356449	0.055560	0.180570
7	0.013373	97.48941	1.904004	0.371080	0.055569	0.179935
8	0.013384	97.45027	1.923851	0.389235	0.055522	0.181118
9	0.013388	97.42813	1.935398	0.399956	0.055504	0.181017
10	0.013390	97.41465	1.940169	0.408390	0.055488	0.181304

Variance Decomposition of D_L_CPI_NA:

Period	S.E.	D_L_GDP_NA	D_L_CPI_NA	D_L_M2_NA	D_L_TBILL_NA	D_D_L_EXC_NA
1	0.028601	0.243272	99.75673	0.000000	0.000000	0.000000
2	0.032707	0.187476	87.08396	12.70390	0.017223	0.007440
3	0.034948	0.179100	78.18169	21.42475	0.023464	0.190995
4	0.035955	0.211450	74.61769	24.96126	0.025245	0.184354
5	0.036466	0.253480	72.77758	26.72480	0.026814	0.217328
6	0.036689	0.293707	72.01287	27.45016	0.027344	0.215926
7	0.036800	0.323105	71.61820	27.80921	0.027760	0.221720
8	0.036848	0.343325	71.44932	27.95801	0.027914	0.221425
9	0.036872	0.355717	71.36368	28.03015	0.028019	0.222434
10	0.036882	0.363137	71.32671	28.05972	0.028060	0.222370

Variance Decomposition of D_L_M2_NA:

Period	S.E.	D_L_GDP_NA	D_L_CPI_NA	D_L_M2_NA	D_L_TBILL_NA	D_D_L_EXC_NA
1	0.011763	3.868339	1.703162	94.42850	0.000000	0.000000
2	0.013471	5.321160	1.303761	92.47867	0.033853	0.862560
3	0.013949	6.348701	1.462464	91.31467	0.036598	0.837567
4	0.014196	6.829901	1.444364	90.76878	0.040735	0.916218
5	0.014285	7.116396	1.471210	90.45984	0.041425	0.911125
6	0.014333	7.252232	1.465379	90.31769	0.042245	0.922451
7	0.014350	7.327849	1.467331	90.24113	0.042404	0.921289
8	0.014360	7.363484	1.465712	90.20529	0.042569	0.922949
9	0.014363	7.382258	1.465557	90.18687	0.042604	0.922708
10	0.014365	7.390984	1.465202	90.17824	0.042636	0.922940

Variance Decomposition of D_L_TBILL_NA:

Period	S.E.	D_L_GDP_NA	D_L_CPI_NA	D_L_M2_NA	D_L_TBILL_NA	D_D_L_EXC_NA
1	0.652038	1.552999	0.103293	0.028038	98.31567	0.000000
2	0.665575	1.671121	2.203560	0.178515	95.87246	0.074340
3	0.666858	1.695209	2.260478	0.413481	95.52447	0.106357
4	0.667387	1.704749	2.312614	0.498759	95.37350	0.110375
5	0.667728	1.706475	2.319880	0.580351	95.27595	0.117346
6	0.667852	1.706463	2.327540	0.607608	95.24057	0.117824
7	0.667930	1.706161	2.328811	0.627453	95.21847	0.119109
8	0.667958	1.706016	2.330173	0.634256	95.21039	0.119170
9	0.667975	1.705940	2.330394	0.638764	95.20550	0.119402
10	0.667982	1.705936	2.330630	0.640350	95.20368	0.119409

Variance Decomposition of D_D_L_EXC_NA:

Period	S.E.	D_L_GDP_NA	D_L_CPI_NA	D_L_M2_NA	D_L_TBILL_NA	D_D_L_EXC_NA
1	0.040939	0.004739	1.356851	6.699564	1.156663	90.78218
2	0.051319	0.039858	5.622636	10.12658	0.829356	83.38156
3	0.054849	0.042178	5.798013	11.26999	0.753350	82.13647
4	0.056170	0.044401	6.059110	11.32620	0.727049	81.84324
5	0.056751	0.044186	6.087968	11.52385	0.716304	81.62769
6	0.056965	0.044956	6.127483	11.52439	0.712300	81.59087
7	0.057063	0.044832	6.131971	11.55965	0.710545	81.55301
8	0.057099	0.045074	6.138580	11.55894	0.709881	81.54752
9	0.057115	0.045048	6.139303	11.56528	0.709586	81.54079
10	0.057121	0.045116	6.140414	11.56505	0.709474	81.53995

Cholesky Ordering: D_L_GDP_NA D_L_CPI_NA D_L_M2_NA D_L_TBILL_NA D_D_L_EXC_NA

Case 3: Estimation of Structural VAR with (gdp, cpi, m2, tbill and exc)
Case 3.1: recursive ordering

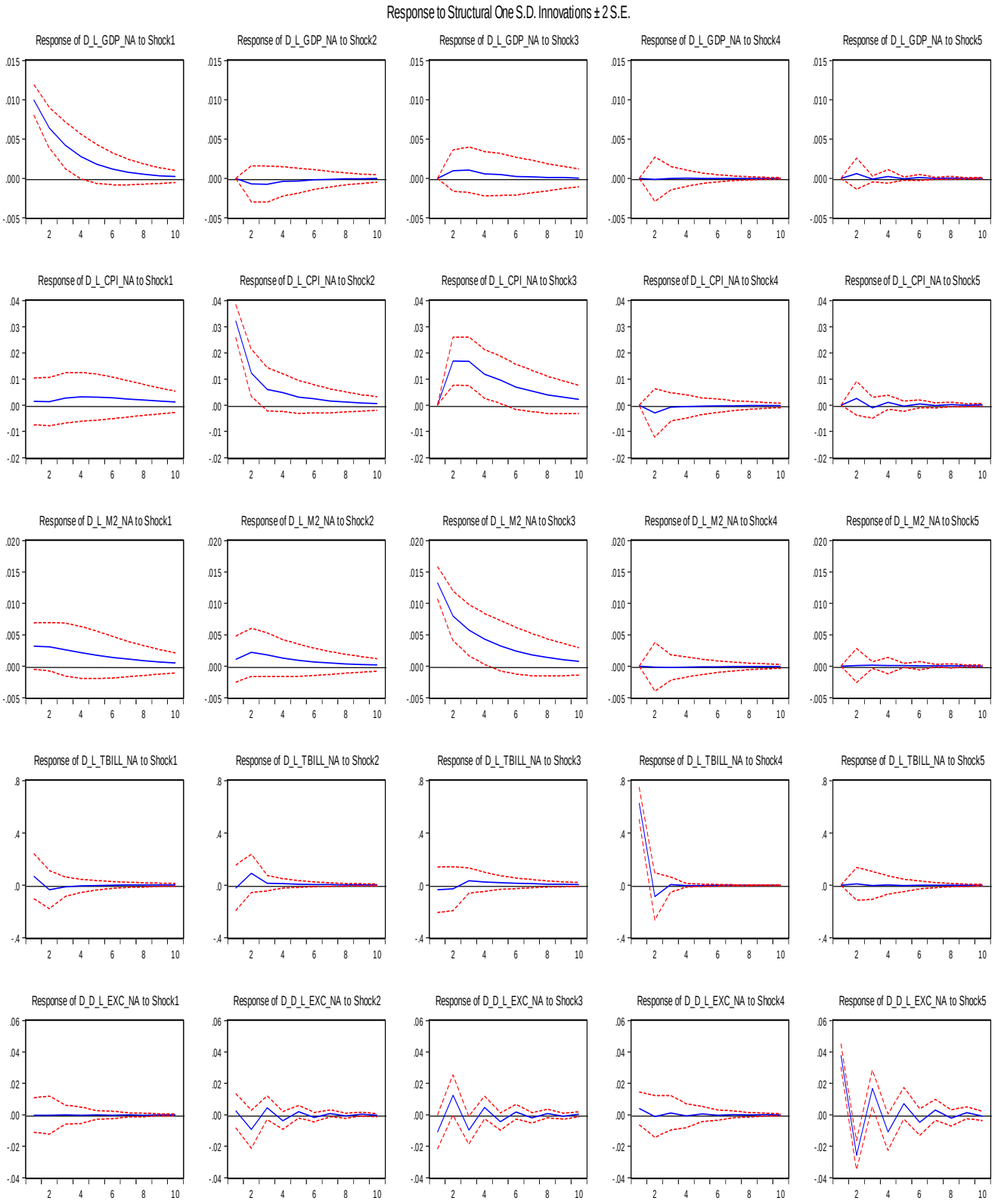
Structural VAR Estimates
Date: 07/17/12 Time: 13:55
Sample (adjusted): 1998Q4 2011Q4
Included observations: 53 after adjustments
Estimation method: method of scoring (analytic derivatives)
Convergence achieved after 10 iterations
Structural VAR is just-identified

Model: Ae = Bu where E[uu']=I
Restriction Type: short-run text form
@e1 = C(1)*@u1
@e2 = C(2)*@e1 + C(3)*@u2
@e3 = C(4)*@e1 + C(5)*@e2 + C(6)*@u3
@e4 = C(7)*@e1 + C(8)*@e2 + C(9)*@e3+ c(10)*@u4
@e5 = C(11)*@e1 + C(12)*@e2 + C(13)*@e3 + C(14)*@e4 + C(15)*@u5

where
@e1 represents D_L_GDP_NA residuals
@e2 represents D_L_CPI_NA residuals
@e3 represents D_L_M2_NA residuals
@e4 represents D_L_TBILL_NA residuals
@e5 represents D_D_L_EXC_NA residuals

	Coefficient	Std. Error	z-Statistic	Prob.
C(2)	0.144627	0.443803	0.325882	0.7445
C(4)	0.313052	0.182536	1.715018	0.0863
C(5)	0.034067	0.056440	0.603599	0.5461
C(7)	7.865969	8.859684	0.887839	0.3746
C(8)	-0.546182	2.675558	-0.204137	0.8382
C(9)	-2.650232	6.489395	-0.408394	0.6830
C(11)	0.178583	0.538975	0.331339	0.7404
C(12)	0.110452	0.161633	0.683351	0.4944
C(13)	-0.814591	0.392492	-2.075433	0.0379
C(14)	0.006324	0.008295	0.762350	0.4459
C(1)	0.010015	0.000973	10.29563	0.0000
C(3)	0.032358	0.003143	10.29563	0.0000
C(6)	0.013295	0.001291	10.29563	0.0000
C(10)	0.628118	0.061008	10.29563	0.0000
C(15)	0.037930	0.003684	10.29563	0.0000
Log likelihood	476.8550			
Estimated A matrix:				
1.000000	0.000000	0.000000	0.000000	0.000000
-0.144627	1.000000	0.000000	0.000000	0.000000
-0.313052	-0.034067	1.000000	0.000000	0.000000
-7.865969	0.546182	2.650232	1.000000	0.000000
-0.178583	-0.110452	0.814591	-0.006324	1.000000
Estimated B matrix:				
0.010015	0.000000	0.000000	0.000000	0.000000
0.000000	0.032358	0.000000	0.000000	0.000000
0.000000	0.000000	0.013295	0.000000	0.000000
0.000000	0.000000	0.000000	0.628118	0.000000
0.000000	0.000000	0.000000	0.000000	0.037930

APPENDIX 16 Impulse response for case 3.1



APPENDIX 17 Variance decomposition for case 3.1

Variance Decomposition of D_L_GDP_NA:

Period	S.E.	Shock1	Shock2	Shock3	Shock4	Shock5
1	0.010015	100.0000	0.000000	0.000000	0.000000	0.000000
2	0.011968	98.72310	0.341510	0.681380	0.011354	0.242655
3	0.012752	97.83628	0.634476	1.299493	0.010015	0.219738
4	0.013068	97.63024	0.695464	1.420969	0.009662	0.243666
5	0.013206	97.48948	0.739201	1.522179	0.009468	0.239676
6	0.013263	97.45339	0.748842	1.544549	0.009411	0.243809
7	0.013288	97.42723	0.756317	1.564013	0.009376	0.243068
8	0.013299	97.42025	0.757937	1.568617	0.009365	0.243827
9	0.013304	97.41517	0.759238	1.572548	0.009359	0.243687
10	0.013306	97.41377	0.759508	1.573537	0.009356	0.243828

Variance Decomposition of D_L_CPI_NA:

Period	S.E.	Shock1	Shock2	Shock3	Shock4	Shock5
1	0.032390	0.199974	99.80003	0.000000	0.000000	0.000000
2	0.038777	0.258595	79.84330	18.86524	0.564824	0.468038
3	0.042774	0.622180	67.62428	30.81832	0.493007	0.442214
4	0.044779	1.069937	62.84486	35.15984	0.460156	0.465205
5	0.046012	1.465488	59.96050	37.68360	0.443496	0.446921
6	0.046673	1.783697	58.54621	38.78850	0.433810	0.447785
7	0.047078	2.012136	57.65831	39.46038	0.428501	0.440673
8	0.047300	2.171204	57.18752	39.77621	0.425328	0.439736
9	0.047434	2.275476	56.89622	39.96749	0.423537	0.437276
10	0.047508	2.342775	56.73733	40.06072	0.422475	0.436708

Variance Decomposition of D_L_M2_NA:

Period	S.E.	Shock1	Shock2	Shock3	Shock4	Shock5
1	0.013716	5.390795	0.645921	93.96328	0.000000	0.000000
2	0.016316	7.362339	2.266784	90.36138	0.006160	0.003336
3	0.017591	8.568698	2.979117	88.41900	0.019801	0.013383
4	0.018293	9.341785	3.248410	87.36894	0.025979	0.014887
5	0.018686	9.847440	3.368228	86.73796	0.028857	0.017512
6	0.018909	10.17129	3.418052	86.36217	0.030376	0.018116
7	0.019036	10.37695	3.441476	86.13154	0.031132	0.018910
8	0.019108	10.50452	3.451303	85.99348	0.031547	0.019150
9	0.019149	10.58279	3.455920	85.91013	0.031761	0.019399
10	0.019172	10.62994	3.457781	85.86091	0.031880	0.019489

Variance Decomposition of D_L_TBILL_NA:

Period	S.E.	D_L_GDP_NA	D_L_CPI_NA	D_L_M2_NA	D_L_TBILL_NA	D_D_L_EXC_NA
1	0.633273	1.206052	0.105760	0.309588	98.37860	0.000000
2	0.647008	1.425186	2.067940	0.452985	96.02912	0.024773
3	0.648269	1.452160	2.121397	0.740248	95.66011	0.026089
4	0.648905	1.455680	2.161000	0.883045	95.47343	0.026841
5	0.649287	1.454193	2.175706	0.981726	95.36139	0.026980

6	0.649492	1.453586	2.184310	1.033600	95.30134	0.027162
7	0.649617	1.454028	2.187898	1.066354	95.26455	0.027167
8	0.649688	1.455006	2.189964	1.083816	95.24400	0.027214
9	0.649731	1.456019	2.190845	1.094477	95.23145	0.027211
10	0.649755	1.456880	2.191347	1.100214	95.22433	0.027224

Variance Decomposition of D_D_L_EXC_NA:

Period	S.E.	Shock1	Shock2	Shock3	Shock4	Shock5
1	0.039789	0.002676	0.409369	7.716800	0.996497	90.87466
2	0.049883	0.005043	3.722121	11.19266	0.679422	84.40076
3	0.053717	0.004357	3.892644	12.94668	0.634135	82.52219
4	0.055163	0.007546	4.131173	12.98747	0.617051	82.25676
5	0.055843	0.008020	4.146495	13.29920	0.610523	81.93576
6	0.056101	0.009971	4.190119	13.28745	0.607702	81.90476
7	0.056229	0.010601	4.191056	13.35434	0.606527	81.83748
8	0.056276	0.011511	4.199838	13.34867	0.606007	81.83397
9	0.056300	0.011880	4.199614	13.36379	0.605784	81.81894
10	0.056309	0.012248	4.201431	13.36200	0.605685	81.81864

Factorization :Structural

Case 3.2: non recursive ordering method

The hessian is near singular; therefore I could not have the result.

Case 4: Estimation of SVAR with (gdp,cpi,m2,tbill,exc, export, fed and oilp)
Case 4.1 Recursive ordering
APPENDIX 18 STRUCTURAL VAR Estimation

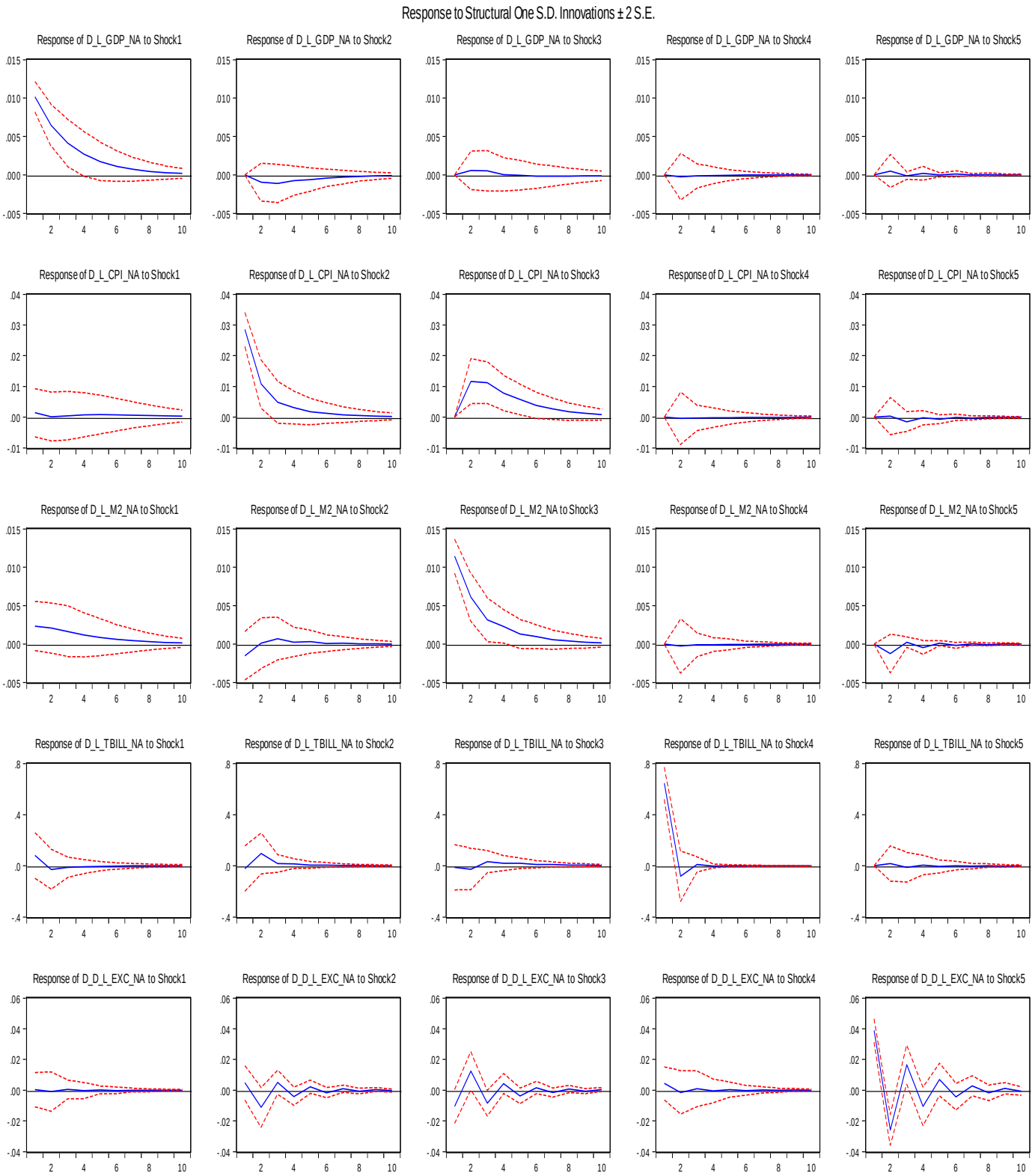
Structural VAR Estimates
Date: 07/17/12 Time: 12:52
Sample (adjusted): 1998Q4 2011Q4
Included observations: 53 after adjustments
Estimation method: method of scoring (analytic derivatives)
Convergence achieved after 10 iterations
Structural VAR is just-identified

Model: Ae = Bu where E[uu']=I
Restriction Type: short-run text form
@e1 = C(1)*@u1
@e2 = C(2)*@e1 + C(3)*@u2
@e3 = C(4)*@e1 + C(5)*@e2 + C(6)*@u3
@e4 = C(7)*@e1 + C(8)*@e2 + C(9)*@e3+ c(10)*@u4
@e5 = C(11)*@e1 + C(12)*@e2 + C(13)*@e3 + C(14)*@e4 + C(15)*@u5

where
@e1 represents D_L_GDP_NA residuals
@e2 represents D_L_CPI_NA residuals
@e3 represents D_L_M2_NA residuals
@e4 represents D_L_TBILL_NA residuals
@e5 represents D_D_L_EXC_NA residuals

	Coefficient	Std. Error	z-Statistic	Prob.
C(2)	0.138514	0.385285	0.359511	0.7192
C(4)	0.234613	0.154358	1.519925	0.1285
C(5)	-0.053740	0.054964	-0.977720	0.3282
C(7)	8.304265	8.918788	0.931098	0.3518
C(8)	-0.784923	3.136706	-0.250238	0.8024
C(9)	-0.955157	7.769165	-0.122942	0.9022
C(11)	0.165486	0.542481	0.305055	0.7603
C(12)	0.122464	0.189359	0.646730	0.5178
C(13)	-0.920519	0.468804	-1.963545	0.0496
C(14)	0.006810	0.008287	0.821752	0.4112
C(1)	0.010184	0.000989	10.29563	0.0000
C(3)	0.028566	0.002775	10.29563	0.0000
C(6)	0.011431	0.001110	10.29563	0.0000
C(10)	0.646524	0.062796	10.29563	0.0000
C(15)	0.039007	0.003789	10.29563	0.0000
Log likelihood	487.5657			
Estimated A matrix:				
1.000000	0.000000	0.000000	0.000000	0.000000
-0.138514	1.000000	0.000000	0.000000	0.000000
-0.234613	0.053740	1.000000	0.000000	0.000000
-8.304265	0.784923	0.955157	1.000000	0.000000
-0.165486	-0.122464	0.920519	-0.006810	1.000000
Estimated B matrix:				
0.010184	0.000000	0.000000	0.000000	0.000000
0.000000	0.028566	0.000000	0.000000	0.000000
0.000000	0.000000	0.011431	0.000000	0.000000
0.000000	0.000000	0.000000	0.646524	0.000000
0.000000	0.000000	0.000000	0.000000	0.039007

APPENDIX 19 Impulse response for recursive structural VAR



APPENDIX 20 Variance decomposition for the recursive structural VAR

Variance Decomposition of D_L_GDP_NA: Period	S.E.	Shock1	Shock2	Shock3	Shock4	Shock5
1	0.010184	100.0000	0.000000	0.000000	0.000000	0.000000
2	0.012110	98.94814	0.614080	0.219370	0.046424	0.171981
3	0.012863	98.11301	1.313855	0.359005	0.053758	0.160370
4	0.013166	97.83331	1.589673	0.343131	0.054915	0.178966
5	0.013295	97.65158	1.778977	0.337927	0.055598	0.175916
6	0.013350	97.55147	1.855954	0.356449	0.055560	0.180570
7	0.013373	97.48941	1.904004	0.371080	0.055569	0.179935
8	0.013384	97.45027	1.923851	0.389235	0.055522	0.181118
9	0.013388	97.42813	1.935398	0.399956	0.055504	0.181017
10	0.013390	97.41465	1.940169	0.408390	0.055488	0.181304

Variance Decomposition of D_L_CPI_NA: Period	S.E.	Shock1	Shock2	Shock3	Shock4	Shock5
1	0.028601	0.243272	99.75673	7.69E-34	6.15E-31	0.000000
2	0.032707	0.187476	87.08396	12.70390	0.017223	0.007440
3	0.034948	0.179100	78.18169	21.42475	0.023464	0.190995
4	0.035955	0.211450	74.61769	24.96126	0.025245	0.184354
5	0.036466	0.253480	72.77758	26.72480	0.026814	0.217328
6	0.036689	0.293707	72.01287	27.45016	0.027344	0.215926
7	0.036800	0.323105	71.61820	27.80921	0.027760	0.221720
8	0.036848	0.343325	71.44932	27.95801	0.027914	0.221425
9	0.036872	0.355717	71.36368	28.03015	0.028019	0.222434
10	0.036882	0.363137	71.32671	28.05972	0.028060	0.222370

Variance Decomposition of D_L_M2_NA: Period	S.E.	Shock1	Shock2	Shock3	Shock4	Shock5
1	0.011763	3.868339	1.703162	94.42850	3.64E-30	0.000000
2	0.013471	5.321160	1.303761	92.47867	0.033853	0.862560
3	0.013949	6.348701	1.462464	91.31467	0.036598	0.837567
4	0.014196	6.829901	1.444364	90.76878	0.040735	0.916218
5	0.014285	7.116396	1.471210	90.45984	0.041425	0.911125
6	0.014333	7.252232	1.465379	90.31769	0.042245	0.922451
7	0.014350	7.327849	1.467331	90.24113	0.042404	0.921289
8	0.014360	7.363484	1.465712	90.20529	0.042569	0.922949
9	0.014363	7.382258	1.465557	90.18687	0.042604	0.922708
10	0.014365	7.390984	1.465202	90.17824	0.042636	0.922940

Variance Decomposition of D_L_TBILL_NA: Period	S.E.	Shock1	Shock2	Shock3	Shock4	Shock5
1	0.652038	1.552999	0.103293	0.028038	98.31567	0.000000
2	0.665575	1.671121	2.203560	0.178515	95.87246	0.074340
3	0.666858	1.695209	2.260478	0.413481	95.52447	0.106357
4	0.667387	1.704749	2.312614	0.498759	95.37350	0.110375
5	0.667728	1.706475	2.319880	0.580351	95.27595	0.117346
6	0.667852	1.706463	2.327540	0.607608	95.24057	0.117824
7	0.667930	1.706161	2.328811	0.627453	95.21847	0.119109
8	0.667958	1.706016	2.330173	0.634256	95.21039	0.119170
9	0.667975	1.705940	2.330394	0.638764	95.20550	0.119402
10	0.667982	1.705936	2.330630	0.640350	95.20368	0.119409

Variance Decomposition of D_D_L_EXC_NA: Period	S.E.	Shock1	Shock2	Shock3	Shock4	Shock5
1	0.040939	0.004739	1.356851	6.699564	1.156663	90.78218
2	0.051319	0.039858	5.622636	10.12659	0.829356	83.38156
3	0.054849	0.042178	5.798013	11.26999	0.753350	82.13647
4	0.056170	0.044401	6.059110	11.32620	0.727049	81.84324
5	0.056751	0.044186	6.087969	11.52385	0.716304	81.62769
6	0.056965	0.044956	6.127483	11.52439	0.712300	81.59087
7	0.057063	0.044832	6.131971	11.55965	0.710545	81.55301
8	0.057099	0.045074	6.138580	11.55894	0.709881	81.54752
9	0.057115	0.045048	6.139303	11.56528	0.709586	81.54079
10	0.057121	0.045116	6.140414	11.56505	0.709474	81.53995

Factorization: Structural

Case 4.2: Non recursive ordering

The Hessian was near singular and therefore the software cannot give me the result.